AFIT/EN/TR-97-1

FACT BOOK

AFIT RESEARCH, COST AND BENEFIT

OCT. 1997

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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
# AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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Data are presented on the cost and on the benefits of research performed by the graduate students and faculty of the resident schools of the Air Force Institute of Technology (AFIT) at Wright Patterson AFB, Ohio (WPAFB). Costs are calculated by allocating direct and indirect costs of operation to the research function. Research costs per student year for 1996 were found to be $17,809. This is benchmarked against data from the American Society for Engineering Education's Annual Directory of Engineering Graduate Studies and Research where the average of 353 institutions' spending for research per student year was found to be an almost identical $17,840. Benefits were measured from an analysis of seven years (1990 - 1996) of research customer responses to a research assessment form sent to all research sponsors. Both quantitative and qualitative measures of research benefits were extracted from the responses. Quantitative responses for the estimated contract cost of the research averaged $99,182 per MS thesis and $181,000 per Ph.D. dissertation. The qualitative measure of benefits consists of comments of research sponsors about the finished research. Over 100 of these comments are presented in the Appendices. These comments, taken as a whole, may be a better measure of benefit than the quantitative dollar numbers.

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# FACT BOOK:
## AIR FORCE INSTITUTE OF TECHNOLOGY RESEARCH, COST AND BENEFIT

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October 1997

## ABSTRACT

Data are presented on the cost and on the benefits of research performed by the graduate students and faculty of the resident schools of the Air Force Institute of Technology (AFIT) at Wright Patterson AFB, Ohio (WPAFB). Costs are calculated by allocating direct and indirect costs of operation to the research function. Research costs per student year for 1996 were found to be $17,809. This is benchmarked against data from the American Society for Engineering Education's Annual Directory of Engineering Graduate Studies and Research where the average of 353 institutions' spending for research per student year was found to be an almost identical $17,840. Benefits were measured from an analysis of seven years (1990 - 1996) of research customer responses to a research assessment form sent to all research sponsors. Both quantitative and qualitative measures of research benefits were extracted from the responses. Quantitative responses for the estimated contract cost of the research averaged $99,182 per MS thesis and $181,000 per Ph.D. dissertation. The qualitative measure of benefits consists of comments of research sponsors about the finished research. Over 100 of these comments are presented in the Appendices. These comments, taken as a whole, may be a better measure of benefit than the quantitative dollar numbers.

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# 1. Introduction

The Air Force Institute of Technology (AFIT) has been conducting advanced research for the Air Force and other DoD agencies since World War I. The AFIT organizations primarily responsible for conducting this research are its two graduate schools, the School of Engineering (EN) and the School of Logistics and Acquisition Research (LA). Although AFIT's primary product has always been the students who have graduated from AFIT programs, these students have conducted valuable research in scientific, technical, and managerial areas in the process of completing their program requirements. This research has been conducted under the supervision and with the assistance of AFIT faculty and research partners.

Many times in recent years attempts have been made to determine the value of AFIT research in an effort to place an exact dollar value on AFIT research. Unfortunately, there is no precise, reliable metric that can convert research work hours or research results directly into dollar values. However, the lack of a precise, reliable metric does not mean that some approximate assessment of AFIT research value cannot be made. In fact, AFIT has been gathering data pertaining to research value since 1979. This report describes the AFIT assessment of research efforts since 1990.

# 2. Background

Assessment of AFIT research is an ongoing concern. The basic AFIT research assessment instrument is a research assessment form (Fig. 7) attached to every AFIT master's thesis or doctoral dissertation. Most AFIT research is sponsored by an Air Force or DoD agency; the average sponsorship rate since 1990 has been 75%. Sponsors of AFIT research receive copies of theses and dissertations and are asked to provide their estimates of the value of AFIT research both in quantitative and qualitative form.

Sponsors are asked to provide quantitative data by estimating the value in terms of dollar amounts and man-hours of work they believe the research represents. Sponsors provide qualitative data in the form of written comments describing their perception of the significance and impact of the research. Sponsors have not always returned the assessment forms, nor in some cases have they completed all portions when they have returned them. But a significant

percentage has been returned (67% for EN; 50% for LA) that provide support for the discussion of AFIT research data that follows.

## 3. AFIT History

While the quantitative assessment of AFIT research is a recent practice, AFIT's contribution to the Air Force through research is long established. AFIT traces its roots to the early days of powered flight when it was apparent that the progress of military aviation depended upon special education in this new science. In 1919, the Air School of Application was established at McCook Field in Dayton, Ohio, the home of Orville and Wilbur Wright.

When Congress authorized creation of the Air Corps in 1926, the school was renamed the Air Corps Engineering School and moved to Wright Field in 1927. Shortly after the American entry into WWII, the school suspended classes, but it reopened as the Army Air Forces Engineering School in 1944 to conduct a series of accelerated courses to meet emergency requirements.

After World War II, 1946, the Army Air Force Institute of Technology was established. The Institute was composed of two colleges: Engineering and Maintenance, and Logistics and Procurement. These colleges were later re-designated the College of Engineering Sciences and the College of Industrial Administration. When the Air Force became a separate service in 1947, the Institute was renamed the Air Force Institute of Technology. That same year the School of Civil Engineering Special Staff Officers Course began.

The Institute established a logistics education program at WPAFB in 1955, and The Ohio State University conducted the first courses on a contract basis. In 1958, AFIT began a series of short courses in logistics as part of the Air Force Logistics Command (AFLC) Education Center. Later that year, the School of Logistics became a permanent part of AFIT.

In 1954, the 83d Congress authorized the Commander, Air University, to confer degrees upon graduates of the AFIT Resident College. The college was later divided into the School of Engineering, the School of Logistics, and the School of Business. The first undergraduate engineering degrees were granted in 1956, and the first graduate degrees in business in 1958. The School of Business programs were transferred to civilian universities in 1960. In 1963, the

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School of Logistics was re-designated the School of Systems and Logistics. The Civil Engineering Center was also re-designed as the Civil Engineering School.

In 1992 the continuing education and degree functions of the School of Systems and Logistics were split. The continuing education curricula retained the name, School of Systems and Logistics, and the degree curricula were moved to a new School of Logistics and Acquisition Management. With this change AFIT consisted of four schools, two devoted to professional continuing education in logistics, acquisition, and civil engineering, and two devoted to graduate degree programs. That structure remains intact today.

This report on research cost and benefit applies only to the two graduate degree schools, Engineering (EN) and Logistics and Acquisition Management (LA). Most EN master's degrees are 18 months in length, and most LA master' degree programs are 15 months in length. A formal thesis reflecting sound research is a requirement for graduation. EN also offers a Ph.D. degree, typically three years in length which requires a dissertation.

In 1995 The Graduate School of Engineering was a founding partner in the creation of the Dayton Area Graduate Studies Institute (DAGSI). The other two partners were the graduate engineering schools of Wright State University and the University of Dayton. AFIT's involvement permits part time and full time enrollment in AFIT courses by base military and civilian personnel as well as local contractor personnel involved in defense support. It also permits all AFIT students to enroll in courses offered by the other partners, as well as partner school enrollment in AFIT courses. AFIT receives tuition for all DAGSI enrollments. The partnership also encourages joint faculty research projects.

## 4. Current Demographics

AFIT students consist primarily of junior Air Force officers with backgrounds in engineering, applied science, logistics and acquisition. A small percentage of students come from other services, international military services and civilians working for the government. The September 1996 enrollment in EN was 462 full time equivalent (FTE) graduate students of which 30 FTEs represented DAGSI enrollments. Other than DAGSI students, there were no other part-time students. The September 1996 enrollment in LA was approximately 120 (all full time).

The number of EN faculty on 2 April 1997 was 97. This number included 47 military professors and 50 civilian professors. Their academic rank distribution is shown in Figure 1. Academic rank corresponds roughly (but not exactly) with professorial experience. The number of LA faculty on 1 October 1996 was 35 which included 19 civilian professors and 16 military professors.

The number of EN MS graduates during FY 96 was 175. The number of LA MS graduates during FY 96 was 65. The number of EN Ph.D. graduates during FY 96 was 29. Figure 2 shows the number of graduates for the last 10 years. All graduating MS students complete a thesis. The thesis effort is judged to be 6 man-months for EN and 4 man-months for LA. All graduating Ph.D. students complete a dissertation. The dissertation effort is judged to be two man-years.

All faculty are expected to carry out research. In EN, the time allotted for research is 50%. In LA, it is 33%. All of the LA and all of the EN faculty except for five are employed on a 12 month basis. Faculty on a 12 month agreement are given one academic quarter per year free of teaching duties for research. In EN, faculty are expected to spend about 1/3 of their time on research during the three teaching quarters (1/3 of 3/4 plus the research quarter = 50%). LA faculty are expected to spend such time on research during the three teaching quarters to achieve 33% research time for the year. Research time includes the supervision of MS and Ph.D. student research. The five EN faculty not on a 12 month contract are employed on a 10 month contract. They are still expected to devote 50% of their time to research during the year, except that two months (salary) must be funded by research grants and contracts. Current plans are to hire all future EN civilian faculty on the 10 month basis.

## 5. Research Output Metrics

There are three principal categories of research productivity in a university: faculty and student publications, theses and dissertations, and research funding awarded competitively. One hundred and nine peer reviewed journal articles were published by EN faculty and students during FY 96. Other publications (conference papers, invited articles, book chapters) numbered 162. The corresponding numbers for LA faculty and students were 18 reviewed papers and 38 others.

Historical data on number of articles published are shown in Figure 3. The number of MS Theses for FY 96 was 175 for EN and 65 for LA. Historic numbers for Theses will match the number of graduates in Figure 2. The number of Ph.D. (EN only) dissertations was 29 for FY 96. Again, historic numbers will match the number of graduates in Figure 2.

Funded research dollars are included here as an output metric because a faculty's ability to attract outside research funds is a measure of research value and output. Outside funding in the form of funds transfer, grants, and contracts amounted to $3.4M in FY 97. Historic outside funding is shown in Figure 4. For the majority of AFIT faculty, outside funding cannot be applied to salaries. (The five 10-month contract faculty are the exception.) Outside research funds at AFIT are used for equipment, supplies, contract services, travel and indirect costs of research. AFIT has an indirect rate for research funds computed on the basis of the Office of Management and Budget circular A-21. Since faculty salaries are the larger part of grants to civilian universities, and since AFIT cannot include salaries in research proposals, the AFIT figure of $3.4M corresponds to more than that when compared to the community of civilian universities.

## 6. Comments On The Use Of MS Theses as a Research Output Measure

The US Air Force has long regarded the master's degree as the terminal degree for Air Force officers. While a few officers are selected for Ph.D. programs, the majority will stop at the MS degree. One of the primary reasons for this policy is that Ph.D. education consumes too many years out of a typical 20-year officer career, supposedly limiting "pay-back" to the Air Force. Further, the specialization inherent in a post-Ph.D. career is considered by many to be too specialized to be compatible with the "generalist" career pattern expected of officers, especially at the higher ranks.

As a consequence of treating the MS program as terminal education, the AFIT MS degree program has always been a strong program, typically six academic quarters in length in EN and five academic quarters in length in LA with an intensive research problem, carried out with active faculty mentoring, often in a team situation with the faculty, Ph.D. students and post-doctoral fellows. At some other schools, the MS thesis, if there is one, is a report which is graded as pass/fail by the faculty and the execution of the research behind that report involves

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minimal faculty interaction. The faculty at those schools spend their time with the Ph.D. students because that is the most productive route to research accomplishment. That has never been the culture at AFIT. The MS students at AFIT are often the hands and arms of the faculty making them an extension of the faculty. Significant research at AFIT is accomplished with the direct involvement of MS students.

Testimony to the importance of the AFIT MS thesis as a research output measure is given by the research sponsors' comments in the Appendices and by their assignment of dollar value to the thesis as summarized in Figures 8,9, and 10.

## 7. Research Expenditures

Research in a graduate school serves two purposes; it contributes in a major way to student learning, and it produces useful results and new knowledge that have a value in their own right. At AFIT both purposes are important. For this reason, AFIT student salaries are assigned to the learning function. That, is student salaries are considered to be part of the cost of sending an Air Force student to graduate school for 18 months (MS) or 3 years (Ph.D.) Similarly, faculty salaries during the three teaching quarters (but not the research quarter) are assigned to the teaching function.

Research expenditures then consist of:

1. Faculty salaries during the non-teaching (research) quarter, excluding academic administrators and ten-month-contract faculty.

2. Indirect charges at the OMB A-21 rate for research at AFIT applied to the above salaries. This covers the time by staff, administrators, and support personnel spent in supporting the faculty and students in the research function.

3. Capital expenditures for equipment purchased out of AFIT funds for research purposes.

4. All outside sponsor money (fund transfers, grants and contracts) directed to specific research projects.

The above four costs have been used by AFIT (EN only) to report to the National Science Foundation's annual Survey of Research and Development Expenditures at Universities and Colleges. The totals reported for the past three years have been:

AFIT EN Research Expenditures: Minimum calculation

|  | AFIT funds (1.)+(2.)+(3.) | Sponsor funds (4.) | Total | * average enrollment | * research $ per student yr. |
|---|---|---|---|---|---|
| FY 94 | $4,630,000 | $2,426,000 | $7,056,000 | 416 | $16,962 |
| FY 95 | $3,731,000 | $2,229,000 | $5,960,000 | 364 | $16,374 |
| FY 96 | $3,586,000 | $2,291,000 | $5,877,000 | 330 | $17,809 |

* not included in the NSF annual submission

An excursion on the above research costs would be to allocate 50% of faculty salaries and salary indirect to research costs rather than 25%. That would include the non-teaching quarter as well as one third of the EN faculty time spent on research during the three teaching quarters. This would parallel practice in those civilian universities where faculty are permitted to charge salary time to outside grants and contracts during the academic year, as well as during the summer term. Using 50% of AFIT faculty salaries results in:

AFIT EN Research Expenditures: Maximum calculation

|  | AFIT funds 2x(1.)+2x(2.) +(3.) | Sponsor funds (4.) | Total | average enrollment | research $ per student yr. |
|---|---|---|---|---|---|
| FY 94 | $7,939,000 | $2,426,000 | $10,038,000 | 416 | $24,130 |
| FY 95 | $7,044,000 | $2,229,000 | $9,273,000 | 364 | $25,475 |
| FY 96 | $6,948,000 | $2,291,000 | $9,239,000 | 330 | $27,997 |

Benchmarks for these AFIT/EN research expenditures per student year can be found in both the American Society for Engineering Education's (ASEE) Annual Directory of Engineering Graduate Studies and Research (1994-95 edition) and from US News and World Report, "America's Best Graduate Schools," 1996 edition. The ASEE Graduate Studies and Research report lists "Inside the College of Engineering" expenditures and the total graduate student enrollment for 353 engineering schools is shown below. The classification "Inside the College of Engineering" excludes expenditures made in other colleges in the university and excludes expenditures in separately funded, but attached university research institutes.

| Total "Inside college" $ | Total Grad. Enrollment | Research $/Student yr. |
|---|---|---|
| $2,162,574,000 | 121,219 | $17,840 |

When all funds are considered, the ASEE report yields the following average:

| Total Research $ | Total Grad. Enrollment | Research $/Student yr. |
|---|---|---|
| $4,711,217,000 | 121,219 | $38,865 |

The US News and World Report description of the top 50 engineering graduate schools lists only the total research expenditures (inside the colleges of engineering, in other colleges and in attached research institutes) as:

| Total Eng. Research $ | Total Grad. Enrollment | Research $/Student yr. |
|---|---|---|
| $3,989,500,000 | 53,700 | $74,292 |

The US News and World Report data is for the 1995 academic year as reported in 1996. The sources of funds contributing to the total expenditures reported in all three of the above tables were both internal and external to the universities.

## 8. Research Benefits

AFIT policy is to obtain sponsorship of all theses and dissertations. The actual sponsorship rate for the last seven years is approximately 75% (Figure 5). Sponsorship means that the problem was either suggested by or endorsed by someone in the Air Force or in DoD. More rarely, the topic was suggested by or endorsed by someone in other federal agencies or from the private sector, the latter through Cooperative Research and Development Agreements (CRDAs) under the Technology Transfer laws. The fraction of sponsorship by these groups is shown in Figure 6 for the last two years.

Because of this emphasis on thesis/dissertation sponsorship, metrics involving theses and dissertations may be a better measure of research benefit to the Air Force than archival journal article publication. The former, especially theses, tend to focus on problems of immediate Air

Force interest, while archival journal articles tend to focus on the theory and method developed for the solution of those problems.

The primary tool for the measure of sponsor benefit has been the Research Assessment form which is sent to all sponsors along with a copy of the competed thesis or dissertation (Figure 7). AFIT has collected and analyzed the responses received from sponsors using this form for the last eight years. As can be seen from a selection of the returned assessment forms in the Appendices, most of these theses and dissertations involved active faculty participation as well as student effort. In fact 33% if the responses for FY 97 which included remarks specifically mentioned the efforts of one or more faculty members in addition to those of the student author. Typical comments included:

a. "Excellent support from the graduate student and each member (Dr. Mykytka, Major Murdock, Major Pohl) of committee."

b. "Student/faculty did a great job"

c. " great program, largely due to the efforts of Don Thompson [student] and Paul King [faculty]."

d. "hope to continue this work as Capt Whiteley [student] and Maj Roggemann [faculty] continue to investigate multispectral target detection"

e. " I enjoyed my interaction/collaboration with AFIT faculty and students"

f. " Maj Griggs and the faculty of the ENS Dept were very helpful"

All sponsors of AFIT theses and dissertations are rewarded with a faculty-student team effort. This is why data on theses and dissertations are presented here as a primary measure of AFIT research benefit to the Air Force. The collected research assessment forms yield both a quantitative and a qualitative measure of research benefit. The quantitative measure is the sponsor's estimate of the cost to perform the work either by contract or by using in-house labor. The qualitative assessment lies in the collected comments or remarks that the sponsors make on the assessment forms.

## 9. Quantitative Research Benefits

During the years 1990-1997, there were a total of 1,783 graduates. Of these 1,336 had sponsors (75%). As it can be seen from Figure 5, the percentage sponsored was higher in the later years than in the earlier years of the time period covered. Of the EN sponsored theses and dissertations, 897 research assessment forms were returned (67%). During these same years the School of Logistics and Acquisition Management had a total of 679 graduates. The total number of forms returned was 341 for an LA return rate of 50%. Figures 8 and 9 show the distribution of responses to the question "If AFIT had not done this work, please estimate what would it have cost your organization to do it?" for EN theses and for dissertations respectively. (Distribution of responses is not available for LA theses.) The data cover all responses received from mid 1990 through the end of FY 1997. As can be seen from the figures, the sponsor's estimate of the average cost to duplicate an EN MS thesis was $102,500, and the average cost per dissertation was $181,000. The seven year estimate of the average cost to duplicate an LA theses was $91,270. The combined average for MS thesis for the two schools was $99,182. These responses and their average values are estimates or judgments by the sponsors. They do not represent out-of-pocket expenditures by the sponsors.

Figure 10 shows the year-by-year average value of the answer to the question "If AFIT had not done this work, please estimate what would it have cost your organization to do it?" The data in this figure is for both EN and LA (but excludes EN dissertations).

Question two on the Research Assessment form is: "Would you have completed this work if AFIT had not done it?" Typically, the positive responses were over 90% during the first years of this sample (1990-1992), but then positive responses began declining in the subsequent years. Incomplete 1997 returns show only a 56% positive response. At the same time, the responders have been spontaneously offering comments (under this question) such as *"Funds have been too tight for us to contract for this work, and our personnel have been too heavily loaded for us to complete the work in-house."* Before 1995, AFIT reported average cost values in the annual research report by counting only those dollar responses which had a "yes" answer to the question "Would you have completed this work if AFIT had not done it?" As comments such as the one above became numerous, it was obvious that this question invited misleading answers. The data presented here in Figures 8, 9 and 10 include all dollar responses, regardless of the answer to

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question, "would you have done the work?" Because of this re-interpretation, the values presented here do not exactly agree with those published in the annual AFIT research reports.

Data concerning the answers to question "... how would you rate this work" are given in Figure 11. The responses are dominated by "highly significant" and "significant." In rare cases, the significance answer does not correlate well with the dollar value. For instance, "highly significant" was coupled with a cost estimate of $5000 or "slightly significant" was accompanied by a cost estimate of $300,000) . The practice has been to enter zero for the cost if the responder says the work had no significance, even if the responder gave a non-zero cost.

## 10. Qualitative Research Benefits

The sponsors' qualitative judgments about the benefit of AFIT research are illustrated by the collected comments in the Appendices. These comments were taken from the Research Assessment forms (Figure 7) after those forms were returned by the sponsors. The individual comments were then pasted onto the report documentation page (Standard Form 298) of the corresponding thesis or dissertation. The original assessment forms are on file in the research offices of the two graduate schools. The full text of the theses and dissertations can be examined in the AFIT library or obtained from the Defense Technical Information Center, 8725 John J. Kingman Rd., Ft Belvoir VA 22060.
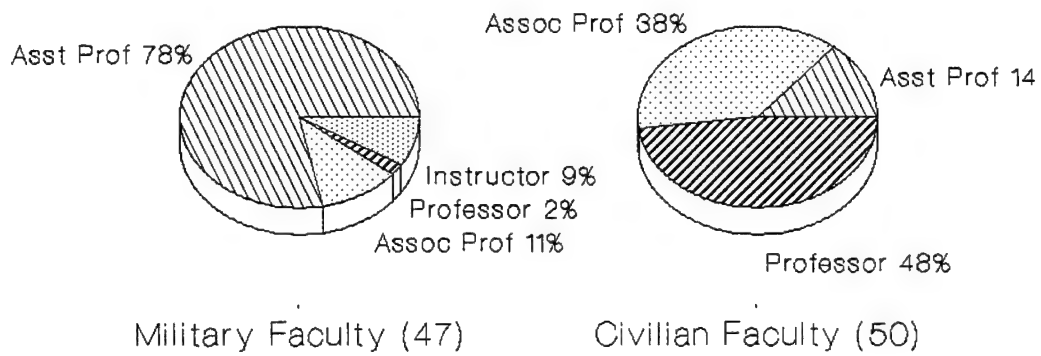
Although they are difficult to summarize, these comments, taken as a whole, may represent a better description of AFIT research benefits than the quantitative numbers presented above.

The Appendices are ordered by type of sponsor:

        A.  Air Force R&D,

        B.  Operational Air Force,

        C.  Other DoD,

        D.  Other federal agencies and

        E.  Private sector (Industry)

Within each appendix, the comments are organized chronologically (1991 comments first, 1997 comments last).

# Figure 1
## Graduate School of Engineering
## Faculty Ranks

Asst Prof 78%

Assoc Prof 38%

Asst Prof 14

Instructor 9%
Professor 2%
Assoc Prof 11%

Professor 48%

Military Faculty (47)          Civilian Faculty (50)

**as of 1 Apr. 97**

# Figure 2
## Total AFIT Graduates

Number

300

250

200

150

100

50

0

EN MS

LA MS

EN PhD

90    91    92    93    94    95    96

Calendar Year

13
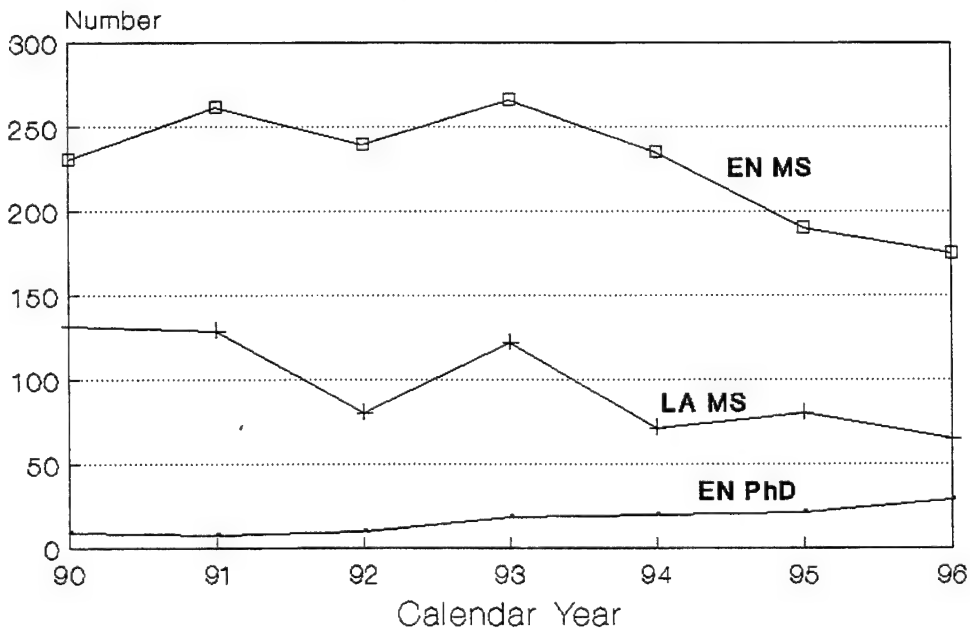
## Figure 3
## Faculty and Student Publications
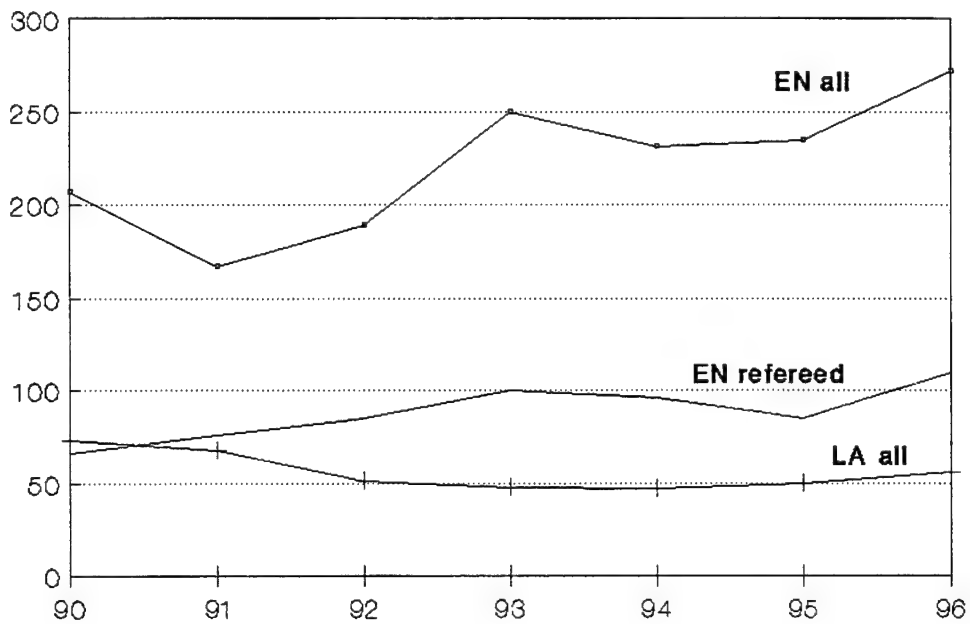


## Figure 4
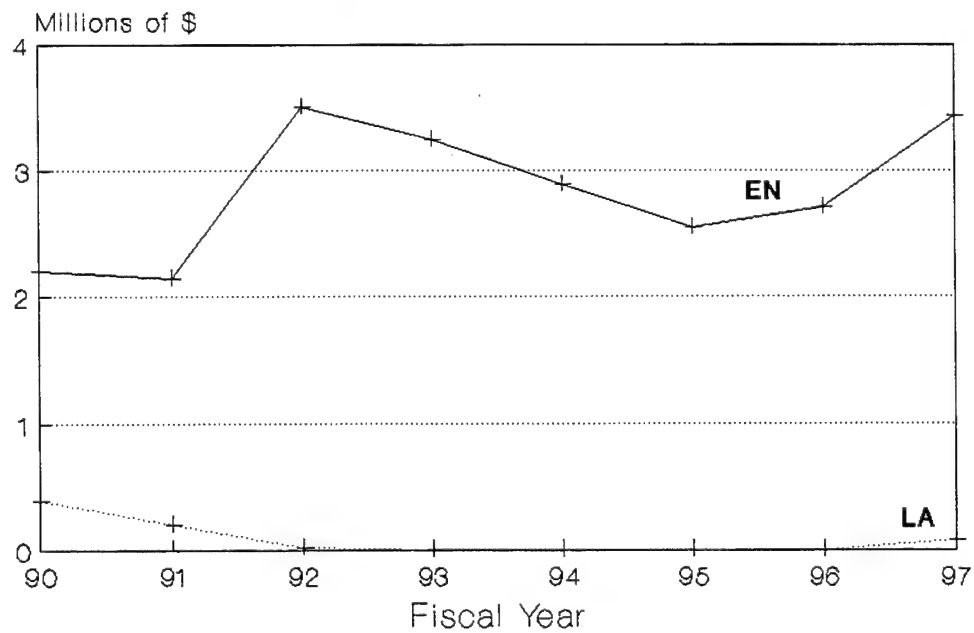## External Research Funding

# Figure 5
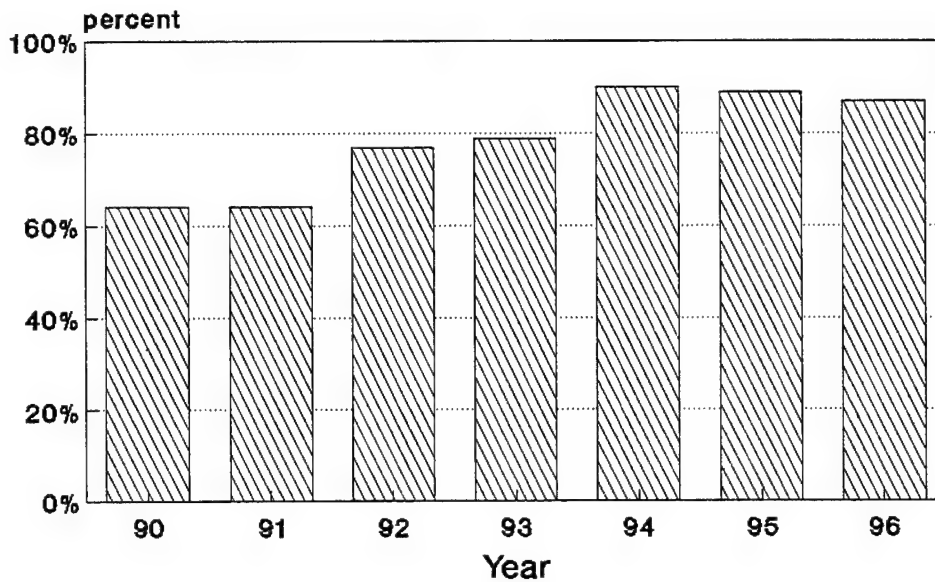## Fraction of AFIT Theses & Dissertations With a Formal Sponsor



# Figure 6
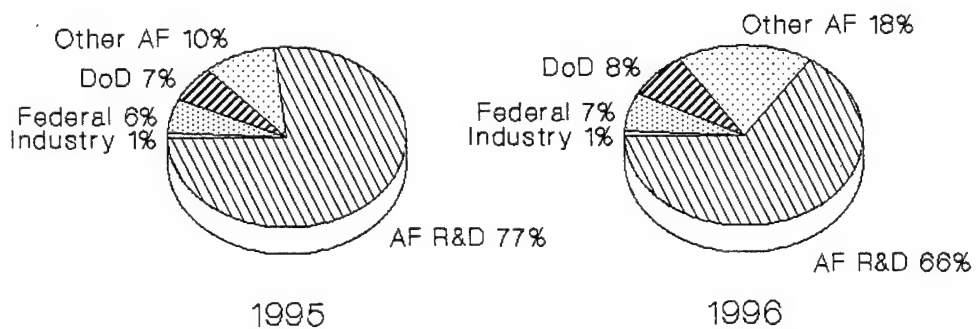## Sponsors of AFIT Theses & Dissertations by Type

# Figure 7

## AFIT RESEARCH ASSESSMENT

To:

Thank you for sponsoring the AFIT thesis or dissertation listed below. AFIT is working hard to keep its research focused on defense technologies of interest to the Air Force and to the nation.

Title:

Student Author:

Designator:

Faculty Chairman:

Please help us determine the value and contribution of this research to you by answering the questions below:

1. Did this research contribute to a current task or goal of interest to your organization?     Y / N

2. Would you have completed this work if AFIT had not done it?                                  Y / N

3. Regardless of your answers above, how would you rate this work?        Highly significant
                                                                          Significant
                                                                          Slightly significant
                                                                          No significance

4. If AFIT had not done this work, please estimate what it would have cost your organization to perform it, either by using in-house resources or by contract.          $_____

5. Would you like to make any remarks? (These will be shared with the academic department and the faculty chairperson.)

You may mail this to AFIT/ENR, 2950 P Street, Wright-Patterson AFB OH 45433-7765 or fax it to 937-656-7302 (DSN 786-7302) or just e-mail your answers (only) to 1 to 5 to enr@afit.af.mil. If you use e-mail, please include the designator above so that we might identify the project. Thank you.

_____          _____
Name of Evaluator                     Office Symbol

_____
Grade/Rank of Evaluator

Figure 8
Distribution of Sponsors' Estimates of
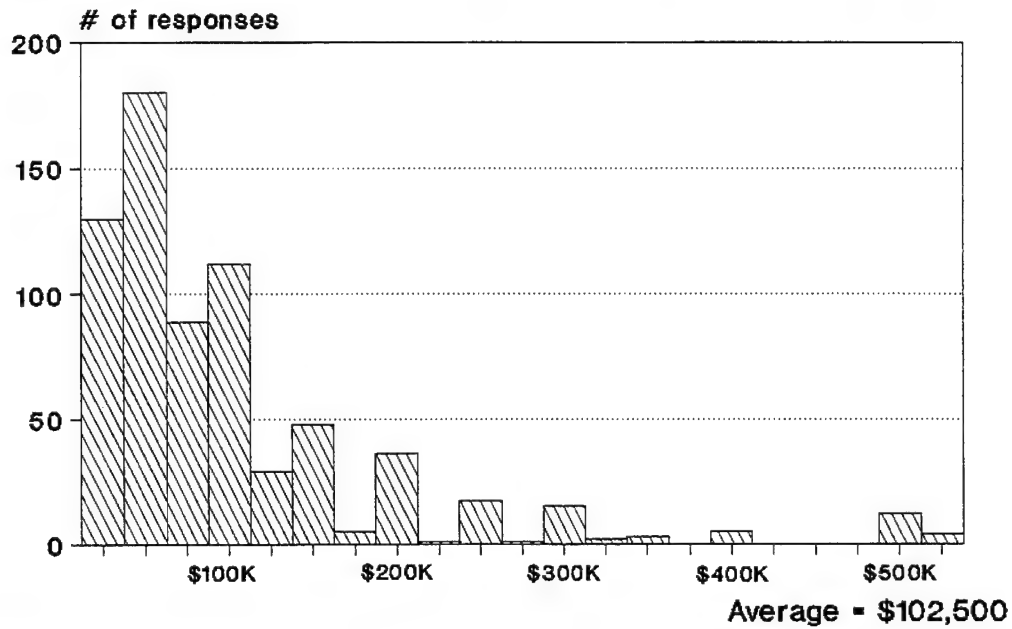Contract Cost for AFIT/EN Theses,1990-97

Average = $102,500



Figure 9
Distribution of Sponsors' Estimates of
Contract Cost for Dissertations, 1990-97
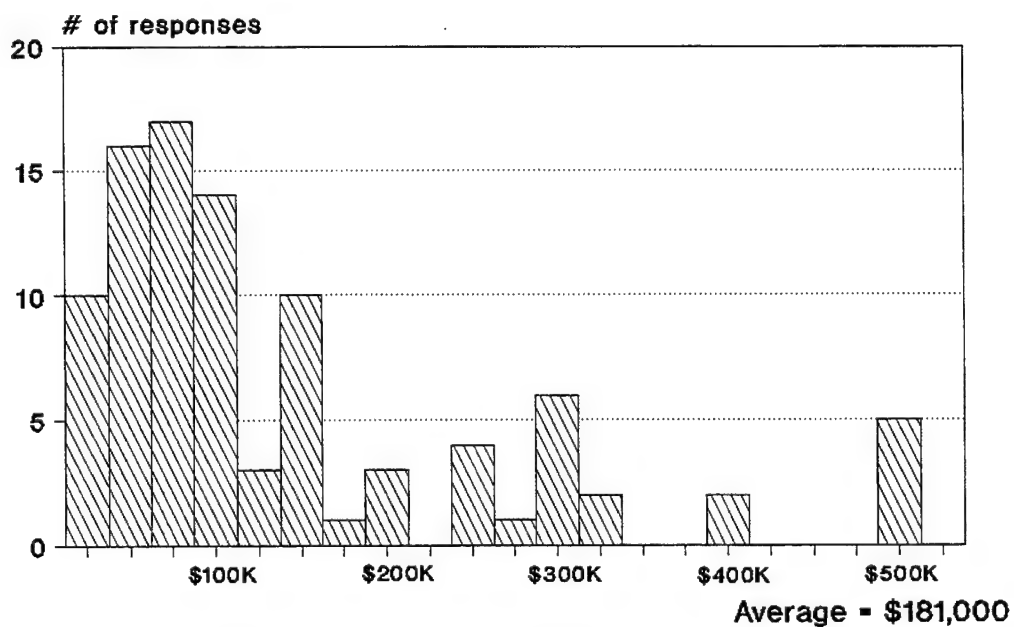
Average = $181,000

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# Figure 10
## Sponsors' Estimate of Contract Cost for AFIT Theses, 1990-96



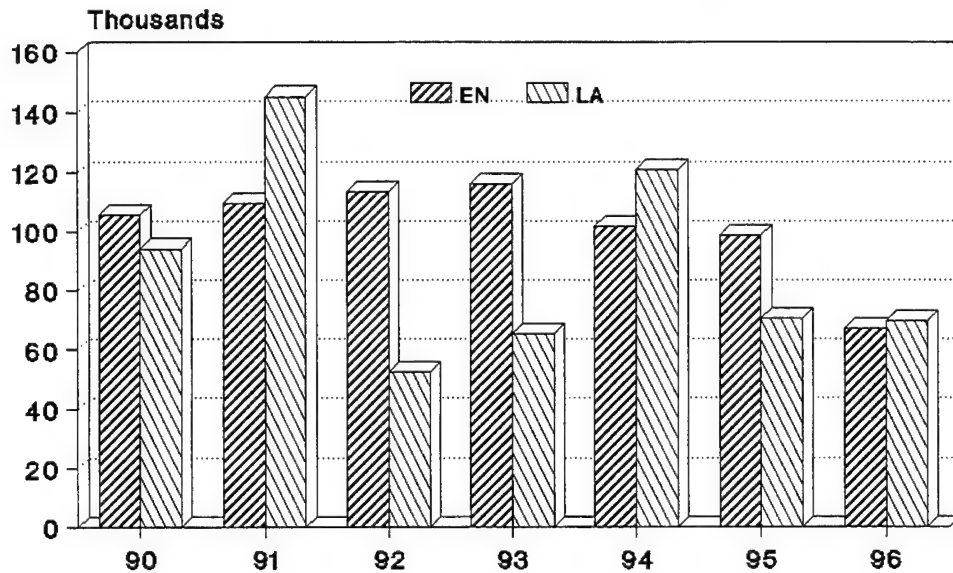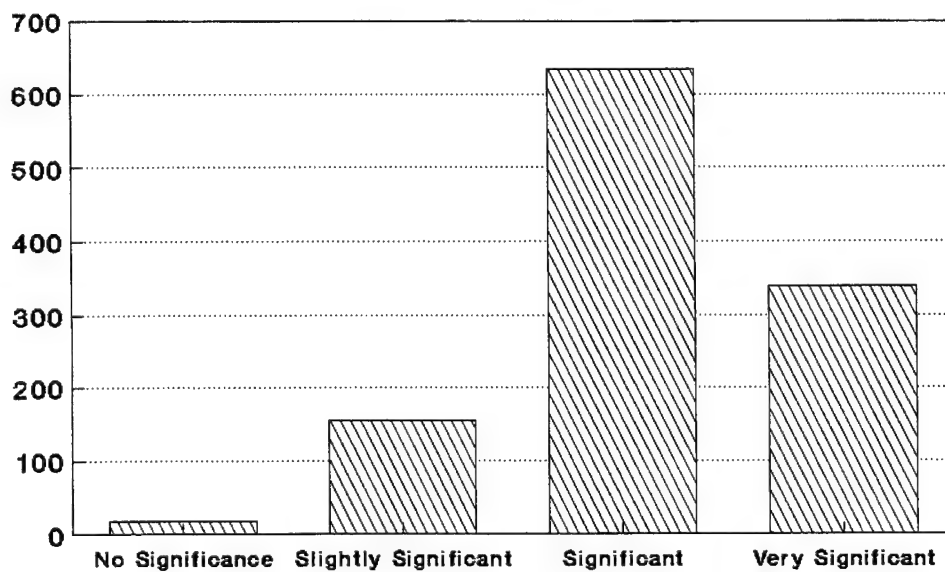# Figure 11
## AFIT Research Assessment Form Answers on Significance

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1991 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**

Validation of the Cross Section and Glint Evaluation System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Michael T. Husar, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

GE/ENG/91D-29

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

WL/AARA
Wright-Patterson AFB OH 45433

The efforts of Capt Husar provided valuable insight into the state-of-the-art in radar cross section (RCS) prediction of aircraft targets. His detailed analysis of the CAGES radar prediction code and insightful recommendations concerning the fidelity of other prediction codes were instrumental in the focusing of $1 million of RCS prediction efforts in this division. Mike's timely analysis significantly accelerated the development of the AAR high range resolution thrust. His unbiased technical evaluation of the fidelity of the RCS prediction code saved the program at least one year in schedule slip. His man-year of effort has pointed the way to substantially improve the technical program which will undoubtedly lead to additional savings to the USAF. Mike's effort is prototypical of the tremendous mutual benefit that AFIT research program affords.

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to US Government agencies. Perf 12 December 1991. Document must be referred to W Wright-Patterson AFB

**13. ABSTRACT** *(Maximum 200 words)*

The Cross Section and Glint Evaluation System (CAGES) is a Radar Cross Section (RCS) prediction software package written by General Dynamics, Pomona, which provides both time and frequency domain output. This simulation package has potential uses in target identification as well as signature prediction of air targets. CAGES uses primitive targets such as flat plates, cylinders and truncated cones to model complicated targets. The electromagnetic theory is based on Physical Optics and Geometrical Optics models. This paper compares the RCS prediction of CAGES primitives to a Uniform Theory of Diffraction (UTD) model and measurement data. Assessments are made on the domain of applicability of CAGES to perform accurate RCS prediction for the target identification role. Also the advantages and disadvantages of modeling and primitives versus modeling with facets and wedges are highlighted. In general, CAGES matches both UTD and measurements in the regions where the specular return is the prominent contributor of the total RCS. The error increases as the aspect angle moves away from the specular return. The main advantage of CAGES over RCS models based on facets and wedges is speed. The greatest disadvantage is the lower resolution available to match primitives to complicated surfaces.

**14. SUBJECT TERMS**

Electromagnetic Scattering, Radar Cross Section, Software Validation, Physical Optics, Primitives

**15. NUMBER OF PAGES**
103

**16. PRICE CODE**

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|---|---|---|
| | December 1991 | Doctoral Dissertation |

**4. TITLE AND SUBTITLE**

Crack Growth Rate Modeling of a Titanium-Aluminide Alloy Under Thermal-Mechanical Cycling

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

John J. Pernot, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/AA/91-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Ted Nicholas
WL/MLLN and AFOSR/NA

ASSESSMENT
BY
ABOVE SPONSOR =

**Capt Pernot has made a significant contribution to the understanding and modeling of crack growth behavior of metals thermomechanical fatigue. The concepts developed and demonstrated in his PhD dissertation constitute an important advance in crack growth modeling. The work is of extreme importance to the ML program in that it provides guidance in the evaluation and characterization of new high temperature metals. The work was of the highest technical quality which could only have been accomplished through a contract program by a team of well trained PhDs.**

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for Public Release; Distribution Unlimited

**13. ABSTRACT** *(Maximum 200 words)*

In this study, a model is developed to predict crack growth rates in a titanium-aluminide alloy under thermal-mechanical fatigue (TMF). This TMF crack growth rate prediction model, which requires only isothermal data to define its parameters, is distinguished from earlier models which requires only isothermal data to define its parameters, is distinguished from earlier models in two ways. First, it accounts for mechanical-fatigue and environmental crack growth rate contributions while is also considers a retardation mechanism thought to be caused by creep blunting of the crack tip. This is the first study to account for such a retardation mechanism during TMF. The second uniqueness of the model is that its general form can account for cycle-dependent crack growth rate contributions that are temperature dependent. In addition, a series of isothermal-fatigue and hold-time tests are performed to generate the data base required for model parameters, and TMF tests are used to validate the modeling technique. The model predicts in-phase, as well as 180 degree and 270 degree out-of-phase crack growth rates extremely well, and underpredicts the 90 degree out-of-phase crack growth rates by a factor of two. Two other, more complex TMF cycles are studied, and the predicted crack growth rates correlate well with the experimental data.

**14. SUBJECT TERMS**

Thermal-Mechanical Fatigue, Thermal Fatigue, Crack Propagation Fatigue, Crack Growth Rates, Life Prediction, Damage Modeling

**15. NUMBER OF PAGES**

318

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1991 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Evaluation of an Interdigitated Gate Electrode Field-Effect Transistor for In Situ Resign Cure Monitoring

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Thomas E. Graham, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/91D-55

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Ms. Frances Abrams
WL/MLBC
Wright-Patterson AFB OH 45433-6583

Although similar work on dielectric cure monitoring and control has been going on in MLBC and other locations for years, there is still much to be done in the area. The AFIT sensor is unique because of its size and we are hoping to do more development on it. The analysis that Capt Graham did was excellent and we will continue to study it. I might add that this effort produced a substantial body of work with almost no expenditure of effort on our part. Capt Graham required much less supervision than any contractor or new in-house effort I have ever managed.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this study was to design an Interdigitated Gate Electrode Field-Effect Transistor (IGEFET) and evaluate its performance as an in situ resign cure monitor. A commercially available resign was selected for the research, and rheological studies were performed to identify the resign's gelation point during isothermal cures at two selected temperatures. Additional rheological studies were performed to identify the resign's glass transition temperature. The interdigitated gate electrode of the IGEFET was coated with samples of the resign, and electrical measurements were performed while the resigned cured. The chemical changes which occur in the resign as a result of curing were manifested in the interdigitated gate electrode's electrical characteristics. The results reveal that the IGEFET is capable of sensing the electrical impedance changes, and hence the chemical changes, which occur during the resign's cure. In particular, the chemical changes due to gelation are evident in the IGEFET's electrical response data. In addition, the resign which was cured at the higher temperature was close to its glass transition temperature, and hence softer than the resign cured at the lower temperature, and the IGEFET was capable of detecting this difference.

**14. SUBJECT TERMS**

IGEFET, Resin Cure Monitoring, Epoxy, CHEFET, Impedance Spectroscopy

**15. NUMBER OF PAGES**

209

**16. PRICE CODE**

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|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br><br>Thermomechanical Fatigue of SCS-6/ 21-S [0/90] Composite | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br>Dana G. Hanson | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GAE/ENY/91D-9 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>WL/MLLN<br>Wright-Patterson AFB OH 45433 | | | |

Capt Hanson did an outstanding job of both conduct-ing experiments and interpreting data, the latter task involved modeling and fractography. The results are of great value to our program in support of NASP.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The objective of this study was to investigate the material behavior of SCS-6/$\beta$21-S [0/90] in a thermomechanical fatigue environment. Samples of the SCS-6/$\beta$21-S composite were subjected to in-phase and out-of-phase cyclic loading. Stress, temperature, and total strain values were acquired during the test sequence and analyzed for indications of possible trends. Experimental results indicated in-phase specimen possessed shorter fatigue lives then their out-of-phase counterparts above the static first ply failure of the matrix. The out-of-phase specimen showed a shorter fatigue life below the first ply failure. The examination of the strain change, modulus change, fractography, and metallography of the in-phase test specimens suggest a fracture mechanism that is fiber dominated. The investigation of these parameters, for the out-of-phase test specimens, indicate the fracture mechanism may be matrix dominated. Additional analysis, using a linear life fracture model and a cumulative damage model, further suggests two parameters govern the fatigue life of SCS-6/$\beta$21-S.

| **14. SUBJECT TERMS**<br><br>Thermomechanical Fatigue, Metal Matrix Composite, Fracture Mechanisms | | | **15. NUMBER OF PAGES**<br>132 |
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| --- | --- | --- |

**4. TITLE AND SUBTITLE**

Binaural Sound Localization Using Neural Networks

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Rushby C. Craig

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/91-D-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Tim Anderson
AL/CFBA
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Currently pursuing follow-on work in-house and possible with AFIT. Very pleased with the effort and results obtained from this work. Results will be reported jointly at a forthcoming Acoustical Society of America meeting.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this study was to investigate the use of Artificial Neural Networks to localize sound sources from simulated, human binaural signals. Only sound sources originating from a circle on the horizontal plane were considered. Experiments were performed to examine the ability of the networks to localize using three three different feature sets. The feature sets used were: time-samples of the signals, mean FFT magnitude and cross-correlation data, and auto-correlation and cross-correlation data. The two different types of sound source signals considered were tones and gaussian noise. The feature set which yielded the best results in terms of classification accuracy (over 91%) for both tones and noise was the auto-correlation and cross-correlation data. These results were achieved using 18 classes (20 degrees per class). The other two feature sets did not produce accuracy results as high or as consistent between the two signal types. When using time-samples of the signals as features, it was observed that in order to accurately classify tones of random-frequency, it was necessary to train with random-frequency tones rather than with tones of one, or a few discrete frequencies.

**14. SUBJECT TERMS**

Neural Nets, Bioacoustics, Acoustic Signals, Sound Signals

**15. NUMBER OF PAGES** 119

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|---|---|---|---|

**4. TITLE AND SUBTITLE**

A Digital Radio Frequency Memory System Using an AFIT Customized CMS VLSI Component

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Emmett L. McGuffin, Jr., Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/92M-06

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Marvin Potts
WL/AAWW-1 and WL/AAWP
Wright-Patterson AFB OH 45433-6543

The DRFM-on-a-Chip program which is progressing thanks to AFIT research is a highly viewed program in WL/AA. This research is opening many doors in the electronic warfare field. Industry is also pursuing a DRFM-on-a-Chip development but lacks some capabilities found in the WL-sponsored AFIT work. The Industry Development is "behind" this work in some aspects.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to DoD and DoD Contractors, Critical Technology, December 1991. Other requests for this documents shall be referred to WL/AAWW-1

**13. ABSTRACT** *(Maximum 200 words)*

AFIT provides research support in the area of digital radio frequency memory (DRFM) to Wright Laboratory. This support includes the design and implementation of a DRFM system. Currently, the research effort is working to place all the functions of a DRFM into a one-chip design in VSLI technology.

The goal of this thesis is to use a customized AFIT VSLI DRFM chip in designing and fabricating a DRFM system. This chip is the implementation of a digital single sideband digital modulator (DSSM). The hardware design provides three major functions of a DRFM in support of the DSSM component. These functions are the analog-to-digital conversion, the digital memory storage, and the digital-to-analog conversion. The analog-to-digital converter and the digital-to-analog converter circuits are designed in ECL technology to operate up to 100 MHz with six bits of resolution. The 100 MHz speed represents the design goals of the VLSI DRFM research. The digital memory unit, which contains the DSSM, operates at 16.66 MHz, the speed of the DSSM. The memory and DSSM components are supported by F series TTL components. This DRFM system operates at 16.66 MHz with six bits of resolution.

**14. SUBJECT TERMS**

Electronic Warfare (EW), Digital Radio Frequency Memory (DRFM), Analog-to-Digital Converter (ADC), Digital-to-Analog Converter (DAC), Digital Modulation, Very Large Scale Integration (VLSI)

**15. NUMBER OF PAGES**
99

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| | December 1992 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Design and Characterization of Optically Pumped Vertical Cavity Surface Emitting Lasers

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Richard J. Bagnell

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENP/92D-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Christopher Keefer, Program Manager, Adaptive Processing Systems
Rome Laboratory, Analog and Lightwave Branch
Griffiss AFB NY 13441-4515

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Clever use of the AO cell to linearly ramp the intensity of your pump. I think valuable information was gleaned concerning VCSELs and they may yet prove useful in optical processing

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

Vertical Cavity Surface Emitting Lasers (VCSELs) are a form of semiconductor laser which have their cavity oriented orthogonally to the plane of the wafer. The orientation necessitates short cavities, highly reflective mirrors and a relatively high gain/loss ratio. Even so, the resultant superior exit beam characteristics and the tight packing density of the finished lasers provide strong motivation for pursuing the growth of these structures. This thesis details the design of an optically pumped InGaAs multiple quantum well periodic gain structure VCSEL with a 950 nm lasing wavelength. These growths were to be a first attempt at VCSEL construction, so part of this study included verification of the quantity of the parts of the finished design. These measurements required the construction of a laboratory configuration to optically pump VCSELs and characterize them by spectral reflectivity, output beam polarization, mode, lasing wavelength, and optimal pump wavelength. Analysis of the characteristics for several VCSELs obtained from the University of Arizona, and the back mirror grown locally, illustrate the ability to use measured data and theoretical spectral reflectivity calculations to determine the quality of the growths.

**14. SUBJECT TERMS**

Semiconductor Lasers, Gallium Arsenide Lasers, Semiconductor Devices, Surface Emitting Lasers, Distributed Bragg Reflector Stack, Vertical Cavity Structure, In-GaAs Quantum Wells

**15. NUMBER OF PAGES**

115

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|---|---|---|
| | March 1992 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Numerical Analysis of Plasma Transport in Tandem Volume Magnetic Multicusp Ion Surfaces

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Todd R. Vitko, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEP/ENP/92M-01

It provides a lucid and comprehensive assessment of the science of volume negative ion sources. This information is presented in a detailed pedagogical manner that is useful to the neophyte and to the practicing researcher. This thesis is brutally honest in its assessment of other works and of its own contributions. The assembled information has achieved its author's objective of being a launch pad for further work in this area. I must also note that it is amazing that a student unfamiliar in plasma physics and numerical analysis was able to catch up and modify a Los Alamos positive ion code, and most importantly, to detect inconsistencies in the formulation and to suggest corrections. While the thesis, strictly speaking did not discover any new physics, it is a very useful resource and it carefully analyzed the assumptions and operation of the inherited Los Alamos code and did not just crank the handle. In fact, the write-up of the author's derivations is one of the best I have read anywhere.

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Alan Garscadden
WL/POOC-3
Wright-Patterson AFB OH 45433

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

A one-diemnsional fluid model of plasma transport in tandem volume magnetic multicusp ion sources is explored. The model, the positive ion source code, pos, by Glasser and Smith, calculates plasma density, drift velocity, electron temperature, and ion temperature in an ion source. The usefulness of the model is limited: (1) The plasma density trend runs opposite to experimental results, and electron temperatures are an order of magnitude higher than experimentally observed. (2) Simplification of the reaction chemistry leads to a plasma balance between ionization and outflow instead of the correct balance between ionization and recombination. (3) Wall losses are neglected. (4) There are inconsistencies in the derivation of some equations,. (5) The final solution depends on the choice of an initial estimated solution. (6) Results of the model are not totally reproducible. (7) Numerical instabilities develop upon modification of terms or variation of initial conditions outside of a marrow range. Calculations of the plasma potential from the results of the model are qualitatively correct.

**14. SUBJECT TERMS**

Boltzmann Equation, Ion Sources, Plasma Simulation, Electron Temperature, Plasma Density, Ion Temperature, Hydrogen Ions, Magnetic Filters, Hydrogen Plasma Chemistry

**15. NUMBER OF PAGES**

134

**16. PRICE CODE**

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**4. TITLE AND SUBTITLE**

APPLYING COMMERCIAL STYLE ACQUISITION PRACTICES TO THE PROCUREMENT OF COMMERCIALLY AVAILABLE AIRCRAFT

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Douglas W. Humerick, Captain, USAF
Steven H. Minnich, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology, WPAFB  OH  45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCM/LSY/92S-6

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

ASD/SDCK
Wright-Patterson AFB OH 45433-5000

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = **Significant and timely research. Job well done.**

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This study was performed to recommend commercial acquisition practices for adoption in government acquisitions of commercially available aircraft. Previous studies, dating to 1972, illustrate the value of adopting commercial style acquisition practices in government acquisitions. Commercial style acquisition practices offer the Government lower costs and faster delivery with no sacrifice of quality. A qualitative analysis of data, collected in telephone interviews of nineteen top level personnel representing twelve domestic aircraft manufacturers, revealed difficulties encountered in selling to the government including: oversight and bureaucracy; payment practices; contract complexity; clause application; and MILSPECs which go beyond FAA certification requirements. Recommendations for acquisition of commercially available aircraft acquisitions included: creating a separate regulation to govern use of commercial practices; using commercial payment practices; requiring cost benefit analysis for MILSPECs and MILSTDs which exceed FAA certifications; removing CAS requirements; establishing a commercial advocate similar to the position of competition advocate; relying on commercial market forces to ensure the manufacturers produce at a low cost and sell at a fair price; and empowering program managers and contracting officers to keep decisions at the lowest possible level and streamline decision making.

**14. SUBJECT TERMS**

Commercial Aircraft, Procurement, Government Procurement Acquisition, Industrial Procurement, Aircraft Industry

**15. NUMBER OF PAGES**

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| 4. TITLE AND SUBTITLE | 5. FUNDING NUMBERS |
|---|---|
| The Effects of Optical Feedback on the Polarization of Vertical Cavity Surface Emitting Lasers | |

**6. AUTHOR(S)**

Gregory J. Vansuch, Capt, USAF

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) | 8. PERFORMING ORGANIZATION REPORT NUMBER |
|---|---|
| Air Force Institute of Technology Wright-Patterson AFB OH 45433-7765 | AFIT/GAP/ENP/93-09 |

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Chris Keefer
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Griffiss AFB NY 13441

**11. SUPPLEMENTARY NOTES**

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The research, though of a preliminary nature, is very important for application of VCSELs in optical processing systems. The issues of optical feedback effects on VCSELs in applications requiring mutually incoherent laser elements is critical in future high speed interconnect schemes. Possible methods of controlling polarization in a VCSEL has applications for differentiating light signals for positive and negative weights in an optical computing architecture. Polarization control also has applications for locking an array of VCSELs for a high power laser source. Further research into electrically controlled VCSELs will have important impacts on the use of these devices in future optical processing systems.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT *(Maximum 200 words)***

Vertical Cavity Surface Emitting Lasers (VCSELs) are a type of semiconductor laser with a cavity oriented orthogonally to the planes of material growth. These lasers differ from conventional edge emitting lasers in several important ways. They have symmetric output beams and they are easily built into two dimensional arrays, making them very attractive as photonic components. The characteristic of interest in this thesis is polarization. While the asymmetric cavities of edge emitters exhibit a clear preference for light polarized in a particular direction, the cylindrically symmetric cavity of a VCSEL has no clear preference. Therefore, it should be relatively easy to change the polarization of a VCSEL. This thesis examines the polarization switching effects of optical feedback from an external reflector. By feeding back various amounts of cross-polarized light, the switching susceptibility of the VCSEL can be determined. Measurements confirmed that the polarization of a VCSEL can be switched through polarized optical feedback, with the degree of switching depending on the strength of feedback. This switching was a relatively rare behavior, indicating that most VCSELs had some type of preferential polarization. This preference could be due to the VCSEL structure itself or the manner in which it was excited.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES 59 |
|---|---|
| Vertical Cavity Surface Emitting Lasers, Optical Feedback, GaAS, AlGaAs, Polarization Switching, VCSEL | 16. PRICE CODE |

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| | June 1993 | Dissertation |

**4. TITLE AND SUBTITLE**

Radome Depolarization Effects on Monopause Receiver Tracking Performance

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Michael A. Temple, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENG/93-03

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Paul J. Westcott
WL/AAWD
Wright-Patterson AFB OH 45433-7765

The EMC Advanced Development Branch of the Electronic Warfare Division, Avionics Directorate, Wright-Laboratory would like to express our appreciation to Capt Temple & Dr. Pyati for their collective efforts in providing invaluable research on radome depolarization effects on monopulse receiver tracking performance. Capt Temple's research and phase front distortion effects yielded exceptional results, providing a firm foundation for further research and developmental efforts. His efforts and results are commensurate with contracted study program typically accomplished by teams of research personnel with far greater corporate experience. Because contractual mechanisms and outside research personnel (non-government) were not required, Capt Temple's efforts resulted in an approximate $240K savings of branch research funds.

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

Boresight Error (BSE), defined as the angular deviation between the true position and the apparent position of a target as indicated by radar, is an important figure of merit for a tracking radar. A significant contributor to system BSE is the protective radome. This research effort employed a GO technique to investigate the effects of a radome on BSE, expanding previous ray-trace receive techniques to include: 1) a uniquely defined/developed mathematical description for each surface within arbitrary multi-layer tapered radomes, 2) an "ideal" taper function concept for obtaining optimum BSE prediction performance, 3) a generalized technique for calculating specular reflection points within the radome, and 4) the total refractive effects along ray propagation paths. Computer model results were compared with limiting case data (BSE = 0 degrees), published experimental data, and production system acceptance test data. For all limiting cases, "system" modeling error was less than .06 mRad. "Excellent" (BSE within $\pm 1$ mRad) results were obtained using hemispheric radome with a displaced aperture gimbal point; predicted BSE values were within $\pm 1$ mRad of published experimental data. Likewise, BSE predictions for the production system were within $\pm 0.5$ mRad of measured data over a 30 degree scan range. Ray refractive effects on BSE prediction were characterized using the validated model.

**14. SUBJECT TERMS**

Radome Depolarization, Boresight Error Prediction, Monopulse Radar, Radome Modeling, Multi-Layer Radomes, Tapered Radomes

**15. NUMBER OF PAGES**

**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

A Theoretical Investigation of Electrically Tunable Birefringent Optical Filters as the Spectral Discriminator in Hyperspectral Imaging Systems

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Duane A. Sauve, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEO/ENP/93D-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Rome Laboratory/OCPC
Griffiss AFB NY 13441

**11. SUPPLEMENTARY NOTES**

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Capt Sauve's description and modeling of birefringent filters for Hyperspectral Imaging is valuable work. His treatment of several tunable Lyot, Solc, and E-O filter concepts was very good, particularly regarding their design and theoretical capabilities. Just as important, he recognized clearly where the research should go next by recommending an excellent sequence of follow-on studies. I heartily endorse such research at AFIT, especially in the coming era where our forces will be depending heavily on advanced sensor technology to provide "near perfect" knowledge of any adversary. Other areas that this hyperspectral technology could be applied to are optical communications and optical information processing, which future AFIT students could pursue in their thesis research.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This study investigated electrically tunable birefringent optical filters for use as the spectral discriminator in hyperspectral imaging systems. Spectral discrimination requirements for hyperspectral imaging systems were defined using specification from two state-of-the-art hyperspectral imaging systems. The spectral discrimination requirements led to the definition of the ideal tunable optical filter for spectral discrimination purposes. Analytical and computer analysis was performed for known birefringent filters which showed promise of electrical tunability, excluding acousto-optics filters. No perfect match was found to the ideal tunable optical filter for hyperspectral imaging defined in this thesis. Both Lyot and Solc based filters exhibited two drawbacks for hyperspectral imaging application: narrow tuning range with linear bandwidth dependence on center wavelength, or wide tuning range and quadratic bandwidth dependence on center wavelength. The n-tuned Solc filter provided the best compromise between tuning range and bandwidth control; however,, it is not practical due to the excessive number of elements required. This thesis provides the needed background for further research in this area and identifies a number of areas for further worthwhile research. Acousto-optic filters offer another possible avenue for hyperspectral imaging and should be investigated. Birefringent materials should also be studied to determine material limits on the electro-optic effect and spectral transmission characteristics to determine practical capabilities of filters discussed in this thesis.

**14. SUBJECT TERMS**

Birefringence, Filters, Multispectral, Imaging, Optical Filters

**15. NUMBER OF PAGES**

66

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| | December 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Analysis of a Wedge-shaped Frequency Selective Surface with Transverse Elements

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Carlos C. Whaley, Jr.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/93D-39

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj Dennis Andersh          Mr. Ed Utt
WL/AARA                     WL/XPNA
Wright-Patterson AFB OH 45433   Wright-Patters

**10. SPONSORING/MONITORING**

This is a very good thesis! Capt Whaley demonstrated an ability to analytically model an extremely difficult electromagnetic problem. Given the short time period to perform the research, it is always difficult to completely validate the effort. I would like to see a follow-on study to construct/measure FSS panels to stress the code's capabilities. Learning what the code cannot predict with accuracy has as much utility as what the code can predict.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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Critical Technology (Dec 1993); All other requests
must be referred to WL/XPN (ASC)
Wright-Patterson AFB OH 45433

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

This thesis describes an efficient method for computer analysis of wedge-shaped finite-by-infinite frequency selective surfaces (FSS). The periodic Green's function for the wedge FSS is not calculated directly. Instead, the Green's function is approximated using image theory and the Geometrical Theory of Diffraction. A method of moments solution for the magnetic scattering currents is obtained using this approximate Green's function. Once the scattering currents have been determined, other parameters of interest, such as radar echo width, are easily calculated.

The method of analysis developed in this thesis has been implemented in a FORTRAN computer program. Comparison of this program's output with measured data from a wedge FSS model indicate that this method of analysis is accurate as well as much faster than a moments method solution using an exact eigenfunction expansion of the Green's function.

**14. SUBJECT TERMS**

FSS, GTD, moment methods, periodic moment method, frequency selective surfaces. diffraction, wedge

**15. NUMBER OF PAGES**

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| | March 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Predicting Armor Piercing Incendiary Projectile Effects After Impacting Two Composite Panels

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jeffrey W. Lanning

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Patricia A. Petitt
WL/FIVS
Wright-Patterson AFB OH 45433-6553

This work is the continuation of a viable working relationship between the Survivability Enhancement Branch and AFIT/ENS. We are currently supporting three AFIT research topics/thesis for the '94 graduation. We are currently attempting to solidify this working relationship with long term projects in this field.

**11. SUPPLEMENTARY NOTES**   ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

Accurate armor piercing incendiary (API) projectile penetration mechanics prediction equations are an essential part of the Air Force's aircraft vulnerability analysis program. Specifically, after aircraft skin perforation, a projectile's residual velocity, residual mass and type of incendiary functioning are used in the analysis of multiple panel impacts and probability of fire ignitions A problem currently facing the Air Force is that the prediction methodologies used for API projectile and graphite/epoxy composite material interactions are inaccurate or nonexistent. This problem was previously addressed for the single composite panel case. This thesis makes use of a designed experiment and the application of empirical methods and classification tools to evaluate existing prediction methodologies and to derive new methodologies for two composite panels. Models are specifically designed to predict the residual mass and residual velocity for a projectile which has penetrated two graphite/epoxy composite panels. Prediction models are developed for 7.62mm, 12.7mm, and 14.5mm API projectiles.

**14. SUBJECT TERMS**

API, Composite Materials, Incendiary Functioning, Vulnerability, Regression Analysis, Discriminant Analysis, Neural Nets

**15. NUMBER OF PAGES**

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|---|---|---|

**4. TITLE AND SUBTITLE**

Failure Mechanisms of High Temperature Semiconductor Lasers

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

David H. Leicester, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Carl Kutsche
WL/ELRD
Wright-Patterson AFB OH 45433

Dave's work was critical to validate the lifetime of the materials/devices currently under development. The research indicated area requiring additional research to allow advances in power, speed, and life-time. The opportunity provided by AFIT (thesis study) saved this organization the cost of contract-ing the work, however, there is a greater benefit. Dave's work was slightly premature for this project, but none knew it until his work was complete. Because of the "thesis studies" flexible nature Dave was able to adopt his research slightly to make the most of his time and ours. We most likely would not have had this opportunity with a contractor. Money and manpower also are benefits. Even though we wanted to do the study, neither money nor manpower were available.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

The primary intent of this research was to determine the influence of three common degradation mechanisms dark area defects, facet degradation, and contact degradation on the operational lifetime of GaAs edge-emitting semiconductor lasers operating in a continuous fashion at 100C. Inherent to this work was the quantified characterization of the lasers during their operation. This characterization arose as the power function as a function of driving current at room temperature before and after their exposure to 100C. Two more similar characterizations were conducted at the beginning and end of each laser's exposure to 100C. An additional means of examining laser degradation came from measuring the current required over time to maintain a constant power output of 5, 7, or 10mW at the elevated temperature. The research demonstrated that facet degradation and contact degradation were minor contributors to the bulk of the data base's degradation. Dark area defects were the primary degradation mechanism as the data's gradually increasing current necessary to maintain constant output will attest. An HF acid rinse on one laser, reacting aggressively to local crystal defects, highlighted the growth of dark area defects toward the lasing cavity due to continued lasing. As a whole, the lasers performed with higher slope efficiencies at elevated temperature, contrary to previous research. This topic deserves more research .

| 14. SUBJECT TERMS Dark area defects, semiconductor lasers, reliability, degradation | | | 15. NUMBER OF PAGES 180 |
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| 4. TITLE AND SUBTITLE<br><br>Characterization of the Dynamic Radar Cross Section Properties of the C-29 Aircraft Using First and Second Order Statistical Moments | 5. FUNDING NUMBERS |
|---|---|
| **6. AUTHOR(S)**<br><br>Robert L. Kehr, Capt, USAF | |

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | 8. PERFORMING ORGANIZATION<br>REPORT NUMBER<br><br>AFIT/GE/ENG/93D-19 |
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| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br><br>Edwin Utt          WL/XPN<br>RATSCAT, 46th Test Group     Wright-Patter:<br>Holloman AFB NM |
|---|

This is a very good thesis that has both financial and technical support from WL/XPN and US Navy at Pax River. Capt Kehr did a superb job (given constraints of time and finances) to analyze the static vs dynamic RCS of the C-29. I feel that Capt Kehr is just beginning to scratch the surface on the topic. This is a very difficult subject area that WL/XPN would be strongly interested in supporting at a larger level if AFIT students are interested.

| 11. SUPPLEMENTARY NOTES    ASSESSMENT<br>BY<br>ABOVE  SPONSOR    = |
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**13. ABSTRACT** *(Maximum 200 words)*

This thesis characterizes the Radar Cross Section (RCS) of the C-29 aircraft, with the intent of developing a prediction model capable of describing the spatial correlation properties of the aircraft's dynamic RCS. The RCS characterization is accomplished through analysis of RCS data obtained from both static and dynamic RCS measurements. A comparison of both the first and second order moments associated with the aircraft's RCS is accomplished. The correlation properties associated with the static, dynamic, and predicted RCS are all compared and the results discussed.

| 14. SUBJECT TERMS<br><br>Dynamic RCS, RCS Predictions | 15. NUMBER OF PAGES<br>114 |
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**4. TITLE AND SUBTITLE**

An Enhanced 2K x 6-Bit Digital RF Memory Integrated Circuit With Electronic Countermeasure Technique Generation

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Calvin H. Kasadate

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Marvin Potts
WL/AAWW-1
Wright-Patterson AFB OH 45433-7318

The research accomplished in this thesis has received high praise from WL/AAW. The ongoing "DRFM on a Chip" project is a feed to current procurement for a coherent digital jammer system. This research also feeds an expendable electronic countermeasures system. I feel the research accomplished through this project puts the Air Force at least 2 yrs ahead of parallel industry efforts. Maj Mehalic and the students should be commended for their excellent work!

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to DoD and DoD contractors only December 1993. Other requests for this document must be referred to WL/AAWW-1, Wright-Patterson AFB OH 45433-7318

**13. ABSTRACT** *(Maximum 200 words)*

An enhanced digital radio frequency memory (DRFM) integrated circuit (IC) was designed and fabricated. The DRFM IC consists of a 2K x 6-bit memory array, a finite state machine (FSM) based memory controller, and a digital single-sideband modulator (DSSM). Maximum operational speed of the DRFM IC was increased by improving the speed of the DSSM circuit from 10MHz to 17 MHz. The speed of the DSSM circuit was increased by designing and incorporating faster arithmetic circuits and introducing pipeline latches into the circuit. Other additional features of the DRFM IC included an external processor interface and a DSSM bypass mode. VHSIC Hardware Description Language (VHDL) model designs for two electronic countermeasure (ECM) generation circuits were completed and validated. The ECM generation circuits were designed to be incorporated into the DRFM IC. The two ECM techniques implemented are the range gate pull-off and the head-to-tail algorithm for generating a continuous wave jamming signal. The two ECM technique generation circuits have been laid out in Magic and validated with HSPICE. However, the Magic layouts have not been placed in pad frames, or sent out for fabrication due to time constraints.

**14. SUBJECT TERMS**

Digital Radio Frequency Memory, DRFM, Electronic Countermeasure Technique Generation, ECM, VLSI, CMOS Integrated Circuits, Electronic Warfare, EW

**15. NUMBER OF PAGES**
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| | December 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Modal Control of a Satellite in an Unstable Periodic Orbit Around the Earth-Sun Interior Lagrange Point

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Douglas J. Hopper, 1Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GA/ENY/93D-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt David J. Pohlen
PL/VTA
Kirtland AFB NM 87117-6008

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

It is of great interest to the Air Force to find methods of controlling satellites to both extend there life-cycle and reduce cost. Although this particular orbit is of little current interest, the search for orbits and controllers that met the condition above are always of interest.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

A periodic "halo" orbit which exists about the interior Lagrange point for the Earth-sun system was decomposed using Floquet theory into modal variables, which are dynamically decoupled subspaces for the six degree of freedom system. Modal control consisted of evaluating the diverging mode and maneuvering to counteract its divergence. In the unperturbed system, this was successful. Control costs were low, and the significance is that the controller did nothing to suppress modes that were oscillatory or converging. The effect of the moon's motion allowed the scheme to operate with reasonable control costs, but the effect of eccentricity caused divergence in spite of the controller.

**14. SUBJECT TERMS**

Floquet Theory, Modal Control, Periodic Orbits, ISEE - 3, Halo Orbits

**15. NUMBER OF PAGES**

93

**16. PRICE CODE**

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A-18

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Predicting The Productive Capacity of Air Force Aerospace Ground Equipment Personnel Using Aptitude and Experience Measures

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert S. Faneuff, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/93M-05

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

AL/HRM
Brooks AFB TX 78235-5601

This thesis publication was timely and made an immediate contribution to the AL/HR research program on productivity capacity. Within a week of receipt, we mailed copies to two research groups, one in the private sector and one in academia, which were recently awarded contracts to continue productive capacity analysis and to refine the con-capital model and instruments to be used in a follow-on field test in FY94. We expect Capt Faneuff's work, to provide a foundation for the private sector firm's work on conceptual model development. The second contractor in academia will be able to build on Capt Faneuff's analysis in a planned assessment of the accuracy and reliability of the supervisor rating of task performance times.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution Unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This study investigated the effects of mechanical aptitude and job experience on the job performance of 204 Air Force Aerospace Group Equipment (AGE) mechanics. Job performance was expressed as *productive capacity (PC)*, which is derived from estimated performance times on job tasks. PC measures were derived for 50 tasks typically performed by airmen in the specialty. Aptitude measures took the form of Mechanical percentile composite scores on the Armed Services Vocational Aptitude Battery (ASVAB). A second-order logistic model was used to regress PC on aptitude and experience at the task level and at the overall job, or aggregate, level. Model R s were generally low. For the tasks, R s ranged from .01 to .13 and for the aggregate model the R was about .16. Generally, experience was a significant predictor but aptitude was not. There was also no indication of an aptitude/experience interaction. These results were verified through forward stepwise regression. There was some evidence that airmen may experience some skill degradation on production-type tasks at around the six year point as they transition to supervisory roles.

**14. SUBJECT TERMS**

Job performance, Productive Capacity, Logistics Regression, ASVAB

**15. NUMBER OF PAGES**

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**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 93 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

Characterization of Nonlinear Effects in Optically Pumped Vertical Cavity Surface Emitting Lasers

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Scott L. Brown, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEO/ENP/93D-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Christopher Keefer
RL/OCPA
Griffiss AFB NY 13441

This research effort characterized VCSEL devices which have applications as optical switches in computing and neural network architectures. These non-linear effects are important for analog systems which need light sources which remain linear over a large dynamic range of output power. Determining the cause of non-linear effects in the VCSEL devices will help with the design and fabrication of devices which either enhance or negate these effects. A current effort is under way at the University of Virginia to develop highly linear devices with respect to input drive current for an analog signal processing application. This effort helped characterize these devices or at least the initial fabrication efforts.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The nonlinear characteristics of optically pumped Vertical Cavity Surface Emitting Lasers (VCSELs) are identified, isolated, and quantified. Three different VCSELs are emulated including two with gain regions of bulk GaAs operating at 875nm and one multi-quantum well (MQW) InGaAs VCSEL operating at 950nm. The nonlinearities evaluated include those due to cavity temperature, carrier injection, and internal lasing field. The VCSELs are pumped by a picosecond/femtosecond Ti:Sapphire laser which is configured to operate in CW, gated CW (minimum gate width was 200ns), picosecond, and gated picosecond modes. A linear relationship is shown between wavelength and substrate temperature, cavity temperature, and injected carriers. It is shown that heating is the dominate nonlinearity in the bulk gain region VCSELs for the pump duty cycles which could be achieved. The MQW VCSEL was dominated by nonlinearities due to carrier population at duty cycles of 10% or less causing the VCSEL to blueshift. A nonlinear relationship is shown between input power and output power and is attributed to the optical Kerr effects in the mirror layers and gain region.

**14. SUBJECT TERMS**

Semiconductor lasers, nonlinear response, VCSEL, optical pumping, GaAs

**15. NUMBER OF PAGES**
89

**16. PRICE CODE**

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| | June 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Manufacturing Tolerance Requirements for Frequency Selective Surfaces

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Edwin V. Chavez

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/93J-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Edwin Utt
WL/XPNA
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This is an excellent introductory analysis of random tolerance efforts of radome/FSS layers. The results are very significant in that they bound the amount of element spacing, element length, and element registration that be tolerated and still allow good transmission performance of planes on radomes. I would like to see the same type of analysis performed for random material effects, as well as push to model on a truly 2D finite panel geometry. Keep up the good work.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT *(Maximum 200 words)***

This thesis investigated the change of radome transmission behavior of Frequency Selective Surfaces (FSS), with errors introduced in slots geometric parameters. Three (3) FSS were analyzed. The first is a single thin conducting plane with an array of 35 columns of thin linear slots in free space. The second is composed of two thin conducting planes with an array of 35 columns of thin linear slots per each FSS in free space. The third consists of two thin conducting planes with an array of 21 columns of thin linear slots per each FSS, embedded in dielectric layers. After designing the ideal FSS with the code known as PMM, Gaussian errors are introduced on lengths, widths, locations of the slot columns and z locations of reference slots in each column, and using a "finite by infinite" array code (SFI) the value of the peak transmitted power and the radiation pattern are obtained several times for different generated Gaussian errors. All the results are tabulated and presented in a statistical and graphical way with the purpose of defining tolerance requirements.

**14. SUBJECT TERMS**

Antenna Theory and Design, Moment Method, Scattering, Radomes, VSWR Broadband Arrays, Frequency Selective Surfaces

**15. NUMBER OF PAGES**

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| | September 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**
A COST MODEL FOR USAF ACQUISITION OF COMMERCIAL
AIRCRAFT FOR SERVICE IN THE SPECIAL AIR MISSION FLEET

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
C. Grant McVicker, Captain, USAF
Michael T. Roche, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology, WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

ASC/SDC, WPAFB OH 45433-6583

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Authors were invaluable assets to air mobility division commercial aircraft acquisition integrated product team.

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

The purpose of this research was to develop a cost estimating model which would allow cost estimators the ability to quickly and accurately estimate the acquisition of Air Force Special Air Mission fleet aircraft. The literature review revealed studies, government contracts, and trade publications which served as source data. This information was supplemented by interviews with acquisition specialists and contractors and incorporated into a database. Several estimating techniques were created and used to estimate the various cost elements. The Commercial Aircraft Integrated Cost Estimating Tool (CAICET) model was then developed to incorporate the estimating techniques with the database. This was accomplished by integrating dialog boxes to access the information and estimate the program acquisition. The CAICET model provides the analyst with the ability to estimate an acquisition program based on a few specific parameters concerning the missionization of the aircraft. These parameters include interior configuration, avionics, mission communications, and self-sufficiency items. Once this information is input, the CAICET model provides the analyst with a real-time estimate in standard AF Form 1537 format.

**14. SUBJECT TERMS**
Cost Models, Aircraft Models, Commercial Aircraft, Air Force
Procurement, Acquisition

**15. NUMBER OF PAGES**
103

**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

A Simulation Approach to Granite Sentry System Analysis

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Marilyn J. Bauer, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION
REPORT NUMBER**

AFIT/GOR/ENS/94M-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Andrew Hachman
AFOTEC/SAL
8500 Gibson Blvd
Kirtland AFB NM 87117-5558

**With current and future operational test and evaluation (OT&E) funding cuts, modeling and simulation are becoming much more important in the evaluation of current and future Air Force Systems. Capt Bauer's research demonstrated that modeling and simulation can be effectively used to assess the operational suitability of command and control systems during OT&E.**

**11. SUPPLEMENTARY NOTES** ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distributed unlimited

**13. ABSTRACT (Maximum 200 words)**

This study demonstrated the use of simulation modelling to analyze Granite Sentry system performance. The availability simulation model constructed provides a number of system performance measures as a function of component MTBFs and MTTRs. Analysis of failure data prior to model construction supported the generally accepted use of expoentially distributed failure rates and lognormally distributed repair times. A Microsoft Windows version of SLAMSYSTEM proved to be an efficient modelling tool, especially during early stages of model development. Guidelines for model use in system analysis are explored through a runtime analysis and a response surface model of system downtime as a function of part redundancy. The runtime analysis provides recommendations for appropriate simulation runtime and number of replications to produce reasonably efficient and accurate results. The response surface analysis highlights three system components whose part redundancy significantly affects system downtime. Finally, the analytical availability model developed was an essential validatediovalidation tool in simulation model development.

**14. SUBJECT TERMS**

Simulation, Availability

**15. NUMBER OF PAGES**
130

**16. PRICE CODE**

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**4. TITLE AND SUBTITLE**
A REQUIREMENTS ANALYSIS FOR AN INTEGRATED MAINTENANCE
INFORMATION SYSTEM APPLICATION INTO THEATER AIR CONTROL
SYSTEM MAINTENANCE

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Morris C. Blumenthal III, Captain, USAF
Stephen W. Starks, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GLM/LAR/94S-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Barbara L. Masquelier, System Engineer
Operational Logistics Branch, Armstrong Laboratory
Human Systems Center. Wright-Patterson AFB OH 45433-7604

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
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**Made major contributions
To IMIS.**

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This research was to determine to what extent Integrated Maintenance Information System (IMIS) functional requirements could satisfy the maintenance information requirements of the ground-based Theater Air Control System. IMIS is a program sponsored by Armstrong Laboratory at Wright-Patterson Air Force Base, Ohio to automate maintenance information. To date, Armstrong Laboratory has only targeted aircraft maintenance for this automated program. The Theater Air Control System contains powerful military radars connected to a mobile communications and computer network. Theater Air Control System maintenance information requirements were identified through a study of the 728th Air Control Squadron at Eglin Air Force Base, Florida, and the existing aircraft requirements matrix for the Integrated Maintenance Information System was modified to meet Theater Air Control System requirements. The small amount of changes required to modify the aircraft matrix in order to satisfy ground TACS requirements indicate that ground TACS is a prime candidate for IMIS technology.

**14. SUBJECT TERMS**
Information Retrieval, Information Transfer, Maintenance Management, Ground
Controlled Interception, Command Control Communications, Management Information Systems

**15. NUMBER OF PAGES**
150

**16. PRICE CODE**

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| | 14 June 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Effects of Thickness and Curvature on the Natural Frequencies of Cylindrical Composite Panels

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jose L. Monteverde, Ecuadorian Air Force

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAE/ENY/94J-2

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Arnold Mayer
WL/FIB
Wright-Patterson AFB OH 45433-7765

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

The careful research led by Prof Palazotto in this difficult area of characterizing aircraft structures built of laminated composite materials fills an important gap relative to understanding the implications of this new material and the identification of the most appropriate modeling methods

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

An analytical study is performed to determine the dynamic response, natural frequencies and mode shapes, of deep composite cylindrical shells, including the effects of through the thickness shear strain. The DSHELL finite element program is used to predict the first four natural frequencies and the results are compared to a reference using the Galerkin technique. The program was extended to problems considering simply supporting-free boundary conditions. The mode shapes are created by plotting a surface-contour plot of the eigenvalue-eigenvector output from DSHELL. A linear free vibration analysis is performed on two graphite/epoxy panels. These panels have different ply orientation. Comparisons between the first panel (used as a baseline) using DSHELL, with previous analytical and experimentation studies were found to correlate well. For the second panel, the curvature and the span to thickness ratio were varied in order to measure effects on two ply orientation: $[0/90°]_s$ and $[-45°/+45°]_s$ under two boundary conditions. The results showed that, as the shell becomes deeper, the frequency becomes smaller. Also as the curvature increases, the frequencies increase.

**14. SUBJECT TERMS**

Linear Dynamics, Eigenvalue-Eigenvector, Finite Element Analysis, Shells, Structural Mechanics, Composite Materials, Numerical Methods

**15. NUMBER OF PAGES**

98

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| | March 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Direct Reduced Order Mixed H-Two/H-Infinity Control for the Short Take-off and Landing/Maneuver Technology Demonstrator (STOL/MTD)

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

William C. Reigelsperger, Jr., 2d Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAE/ENY/94M-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

David Moorhouse
WL/FIMS
Wright-Patterson AFB OH 45433-7922

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

The genesis of this problem was the design of an actual flight demonstrator. The aircraft did fly with control laws designed using LQG/LTR techniques, together with order reduction using engineering judgment. The problem is not pure research, therefore, it does have real practical application . Fight demonstration programs will have comparable complexity. I would be interested in discussing the potential of Lt Reigelsperger's recommendation for future work.

**11. SUPPLEMENTARY NOTES**
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

One of the conclusions from the STOL/MTD program was the need for a multivariable method of designing controllers of low order. This research investigated that problem by studying reduced order mixed H-two/H-infinity control theory applied to the STOL landing configuration which employs both thrust vectoring and the use of a canard. Model matching techniques were used to obtain responses that met handling qualities criteria and reduced pilot workload by decoupling pitch rate and velocity commands The time responses were found through nonlinear simulation and showed that the full order designs did match the ideal models very well and had good noise and wind rejection. Singular value analysis showed that the commands were decoupled very well. The reduced order method was mixed H-two/H-infinity optimization. A fourth order controller that had good performance was found by using a performance constraint, and a fourth order controller that provided good margins was found using a robustness constraint. A third order controller was also found with a performance constraint. Recommendations for finding a low order controller with good performance and robustness are given.

**14. SUBJECT TERMS**

Mixed H-two/H-infinity Optimization, STOL/MTD, Direct Reduced Order Optimization

**15. NUMBER OF PAGES**

157

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| | December 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Second Order Statistical Characterization of Statically and Dynamically Measured Radar Cross-Section

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Michael J. Noble

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/94D-23

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Brian Kent
WL/XPN
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Faced with skyrocketing flight test costs, DoD is very interested in examining alternative techniques for obtaining and interpreting dynamic radar cross section (RCS) data. He successfully extended classical statistical radar characteristics to include the effects of both temporal and spatial variations often encountered in dynamic signature measurements. By building up a modified statistical model, then testing that model with sparsely populated static and dynamic RCS data from a C-29, Capt Noble demonstrated that promising static to dynamic comparisons are possible. Extending his work may allow the Air Force to regularly model the differences between static model and dynamic vehicle flight RCS test data. Integrating Capt Noble's techniques with other data, DoD should save DoD T&E funds.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution Limited to US Government Agencies. Furt Dissemination only as Directed by WL/XPN, Wright-Patterson AFB OH 45433

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

This thesis presents an examination of the second order statistical properties of various forms of Radar Cross-Section (RCS). Past research has shown that the probability of radar detection of a target is a function of the autocovariance of the RCS of the target. Given this fact as motivation, this thesis use dynamic and static C-29, 9.2 GHz RCS measurement data to analyze the RCS autocovariance. The RCS is modeled as a random process with independent variables of observation direction and time. Using this breakout of the RCS and a number of underlying assumptions, RCS autocovariance estimates are generated using the static and dynamic data applied to an autocovariance estimator. Autocovariance predictions are generated using theoretical radar target point scatter distribution models applied to the RCS point scatterer theory. The results of the various estimates and predictions are compared to determine the best combination of RCS measurements and predictions required for creating an accurate characterization of the RCS autocovariance.

**14. SUBJECT TERMS**

Radar Cross-Section, Second Order Statistics, Dynamic RCS, Static RCS

**15. NUMBER OF PAGES**

160

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| Unclassified | Unclassified | Unclassified | UL |

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | 6 June 1994 | Final |

**4. TITLE AND SUBTITLE**

Calibration and Initial Testing of a New Hydraulic Simulator

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Cristian A. Puebla, B.S.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GA/ENY/94J-1

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

1st Lt Michael Meyer
WL/FIVRA
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This research allows us to obtain a better understanding of the complex flow mechanisms during a capsule separation. The needs of future high speed aircraft demand that we provide better protection to the aircrew during ejection. Chris's research provides insight into this problem and the aircrew escape section will build on his research to solve this Air Force problem.

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribute

**13. ABSTRACT (Maximum 200 words)**

In the present research, the flow field associated with the ejection of a crew capsule from the fuselage of a high speed generic aircraft was experimentally investigated by means of the modified gas hydraulic analogy. For this, an existing hydraulic simulator was calibrated and modified to adapt it to the needs of the experiment. The analogy was evaluated for a five-sided capsule alone, and good quantitative agreement with the 2-D shock-expansion theory was obtained. It was found that the size of the model played a key role in the determination of good quantitative data. The analysis of the capsule interacting with a fuselage was made considering it at fixed vertical positions from the fuselage and moving with respect to the fuselage at different constant speeds. A clear difference in water depth ratio distribution on the surfaces of the capsule was found between the static and dynamic conditions and also difference occurred for the various velocities of separation. The agreement between theory and experiment was fair. It was concluded that larger models are needed to get good quantitative agreement between theory and experiment was fair. It was concluded that larger models are needed to get good quantitative agreement between theory and experiment and that any separation study should be made applying a dynamical model.

**14. SUBJECT TERMS**

Gas Hydraulic Analogy, Hydraulic Simulator, Modified Analogy, Aerodynamic Coefficients, Fraud Number, Mach Number, Capsule-Fuselage Interaction, Hydraulic Jump, 2-D Shock-Expansion Theory

**15. NUMBER OF PAGES**

140

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>June 1994 | 3. REPORT TYPE AND DATES COVERED<br>Doctoral Dissertation | |
|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br><br>A Diffraction-based Model of Anisoplanatism Effects in Adaptive Optic Systems | | **5. FUNDING NUMBERS** | |
| **6. AUTHOR(S)**<br><br><br>Steven E. Troxel, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | **8. PERFORMING ORGANIZATION<br>REPORT NUMBER**<br><br>AFIT/DS/ENG/94J-05 | |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>Brent Ellerbroek<br>PL/LIG<br>Kirtland AFB NM 87117-5776 | | **10. SPONSORING/MONITORING<br>AGENCY REPORT NUMBER** | |

| | |
|---|---|
| **11. SUPPLEMENTARY NOTES**<br>ASSESSMENT<br>BY<br>ABOVE SPONSOR = | This thesis topic is an example of significant research which has been overlooked in terms of in-house/contracted work because it does not relate to an immediate crisis. |
| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | **12b. DISTRIBUTION CODE** |

**13. ABSTRACT** *(Maximum 200 words)*

This dissertation presents a new model for computing the angle dependent performance measures of an adaptive-optics system. By incorporating diffraction caused by the index-of-refraction variations of the atmosphere, the phase and amplitude fluctuations of the propagating wave are computed. New theory is presented, that uses the diffraction-based propagation model to yield optical transfer function (OTF) expressions that are more accurate as compared to current theory that neglects diffraction. An evaluation method for calculating the OTF is presented that utilizes a layered atmospheric model and normalized OTF expressions. The diffraction model is also used to present the first OTF signal-to-noise ratio (SNR) expressions that are a function of separation angle between the beacon and the object in an adaptive-optics systems. An evaluation method for the SNR is presented that utilizes normalized correlation functions which are valid over a wide range of atmospheric conditions and correction geometrics. An analysis of the angle dependency of the point spread function (PSF) is presented using the derived OTF expression. The diffraction model is then used to develop a new adaptive-optics wavefront correction algorithm that results in an extended correctable field-of-view (FOV) as compared to current correction algorithms.

| **14. SUBJECT TERMS**<br><br>Adaptive Optics, Atmospheric Optics, Anisoplanatism, Atmospheric Turbulence | | | **15. NUMBER OF PAGES**<br>124 |
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| | | | **16. PRICE CODE** |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Pallet Packing Postprocessor for the Logistics Composite Model

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Gregory S. Taylor, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GST/ENS/94M-11

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Richard Cronk
ASC/XRM
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

We are attempting to incorporate this as a standard post processor in the LCOM simulation system on a Unix computer. We anticipate using the software in support of the Joint Advanced Strike Technology (JAST) program.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to US Government agencies only; Test and Evaluation: Mar 94. Other requests for this document must be referred to ASC/XRECR, Wright-Patterson AFB OH 45433

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

The primary purpose of this research was to develop a pallet packing program to meet the needs of the sponsor, the Resourc Analysis Group, Aeronautical Systems Center, Wright-Patterson AFB OH. The secondary purpose was to develop an analytical method of solving the two-dimensional packing problem to allow comparisons between the solutions generated by the pallet packing program and the optimal solution. The Interactive Pallet Loading System (IPLS) originally developed by Hodgson was used as the core around which were created the various subroutes that accomplished the data manipulation tasks required to meet the needs of the sponsor to transform a list of spares for a future weapon system into a list of loaded pallets. The two analytical models developed were based on the subregion allocation binary programming model of Benabdallah and Wright. This approach allowed the solution of a hybrid two-dimensional problem where both the deviation in height between the boxes in a layer and the area coverage were combined to find the optimal solution. Further advancements in binary programming techniques are required to allow for the use of these models in statistically validating the optimality of the IPLS generated solutions.

**14. SUBJECT TERMS**

Pallet Packing, Packaging, Airlift Operations, Operations Research, Optimization, Mathematical Models, Minimax Technique

**15. NUMBER OF PAGES**

208

**16. PRICE CODE**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE September 1995 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**
CALIBRATION OF THE SOFTWARE ARCHITECTURE SIZING
AND ESTIMATION TOOL (SASET)

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Carl D. Vegas, 1st Lieutenant, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology,
WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCA/LAS/95S-11

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

USAF SMC
El Segundo, CA 90245-4687

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
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**Author did excellent job of documenting SASET model calibration—will be of great value.**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This study attempted to analyze the effect of calibration on the performance of the SASET computer software cost estimating model. Data used for input into the model were drawn from the most current USAF SMC Software Database (SWDB). Once all the records to be used for analysis were identified, the DBMS/Calibration tool (which is part of SASET) was used to perform regression analysis on the relationship between program size (measured in SLOC) and the effort required to develop the program (measured in man-months). Productivity information reported from this tool was then input into equations used to calculate the Productivity Calibration Constants (PCC) and Software Class Multipliers. A comparison was then made between the model's accuracy before calibration and its accuracy after calibration. This was done using records which were not used in calibration (referred to as validation points). Several measures such as mean, variance, mean magnitude of relative error (MMRE), and the percentage method were used to describe accuracy. The majority of the results agreed with previous studies that calibration does improve a model's prediction performance. However, emphasis is placed on the fact that calibration is most useful when the group of calibration data points are homogenous.

**14. SUBJECT TERMS**
Calibration, Software, Cost Estimation, Cost Model, Validation, Regression, SASET, Parametric Analysis, DBMS, Space Projects, Accuracy.

**15. NUMBER OF PAGES**
106

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|---|---|---|
| | March 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Heuristic Approach to Determining Cargo Flow and Scheduling for Air Mobility Command's Channel Cargo System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

John D. Fitzsimmons, Jr., Capt, USAF
John M. Walker, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/94M-05

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

1st Lt Jonathan Robinson
AMC/XPYR
Scott AFB IL 62225

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

I feel that this work has some real potential to be used. Please send a disk with the FORTRAN and SIMSCRIPT code with your data set.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

This research investigated a heuristic approach to schedule aircraft for the channel cargo system of the United States Air Force's Air Mobility Command (AMC). Given cargo/frequency of visit requirements, a fleet of aircraft, and possible routes, the objective of this research was to develop, implement, and tests an iterative procedure to efficiently schedule and load aircraft in order to maximize the flow of cargo through a channel cargo system. Once a level of flow was established, attempts were made to minimize cost in terms of cumulative weighted time-in-system (CWTIS). A minimum cost flow heuristic, incorporating a successive shortest path algorithm, was coupled with a critical arc schedule improvement heuristic Our procedure iterated between these two heuristics to generate a cargo flow pattern and aircraft schedule. This research demonstrated the usefulness and efficiency of this heuristic in planning airlift for the channel cargo system. The FORTRAN programs which implement the heuristics are compatible with current AMC scheduling/advance planning tools. Given this compatibility, additional testing in conjunction with AMC's current planning tools (STORM, CARGPREP, and CARGOSIM) is warranted. Pending successful testing in this environment, implementation of these methods is recommended.

**14. SUBJECT TERMS**

Heuristics, Channel Cargo System, Networks, Schedule, Multicommodity, Shortest-Path, Interchange, Flow Pattern

**15. NUMBER OF PAGES**

148

**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

Analysis of Gravity-Gradient Satellite Attitude Inversion

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jules-Francois D. Desamours

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GSO/ENY/95D-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj David Vallado
PL/VTA
Kirtland AFB NM 87117-5776

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This is good research-related to our Division mission of astrodynamics. We have never received any funds to pursue attitude determination work. Our primary interest is in high accuracy orbit determination methods of initial orbit determination, differential correction and propagation. It would be nice if AFIT could support research in areas such as M-daily model inclusion in SHPU/PPT2 analytic theories or recursion alternatives for multi-day orbits.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this research is to understand and describe the process by which the 1986 Polar BEAR gravity-gradient research satellite of John Hopkins University/Applied Physics Laboratory achieved an orbital attitude correction (re-inversion) from an inverted orientation through the utilization of its momentum wheel. Understanding this process provides an analytical foundation from which a universal attitude inversion process for other gravity-gradient satellites with similar anomalous motions may be sought and developed. The equations of motion for a gravity-gradient satellite with a momentum wheel are derived and implemented in FORTRAN for simulation of the dynamics of the spacecraft. Several re-inversion characteristics are observed, in particular, the dynamics about pitch axis. The resulting observations demonstrate an unexpected non-linear relationship between the oscillation angle of the pitch axis and despin time of the momentum wheel. This phenomenon depends in part on the size of the momentum wheel compared to that of the spacecraft and on the pitch angle at the time of motor torque application.

| 14. SUBJECT TERMS Gravity-Gradient Satellite, Momentum Wheel, Attitude Inversion | | | 15. NUMBER OF PAGES 56 |
|---|---|---|---|
| | | | 16. PRICE CODE |

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE<br>December 1995 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
| --- | --- | --- | --- |
| **4. TITLE AND SUBTITLE**<br><br>An Architecture for Dynamic Meta-Level Process Control for Model-Based Troubleshooting | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br>John E. Friskie, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GCE/ENG/95D-02 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>Nancy L. Crowley, Lt Col, USAF<br>PL/VTQ<br>Kirtland AFB NM 87117-5776 | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |
| **11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR = | **Our relationship with AFIT has been great! I hope it continues.** | | |
| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Distribution Unlimited | | | **12b. DISTRIBUTION CODE** |

**13. ABSTRACT** *(Maximum 200 words)*

There are numerous methods used for troubleshooting devices. Each method has certain domains, knowledge requirements, and assumptions required for it to perform well. However, oftentimes no one method by itself is sufficient to completely solve a troubleshooting. Therefore, an architecture is required to control the combined use of many problem solving methods. The combination of multiple problem solving methods makes the troubleshooting process more robust in terms of device domains that can be dealt with and quality of diagnosis produced. Troubleshooting has two tasks: diagnostics and problem resolution. This research provides an architecture that allows dynamic method selection during diagnosis. Dynamic method selection factors the current state of the diagnosis process along with other method parameters to determine which method to use to advance the diagnosis process. The architecture was developed by combining themes from diagnosis research that focused on dynamic multimethod diagnosis and its control. This work has produced several results. It provides an architecture to organize the methods and a basis for making control decisions concerning method use during diagnosis. It identifies a generous number of methods useful to perform diagnosis. It identifies the knowledge these methods require.

| 14. SUBJECT TERMS | | | 15. NUMBER OF PAGES<br>140 |
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| Artificial Intelligence, Computer Aided Diagnosis, Expert Systems, Meta-Level Inference, Model-Based Reasoning | | | 16. PRICE CODE |
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|---|---|---|
| | December 1995 | Technical Paper Thesis |

**4. TITLE AND SUBTITLE**

Validation of the Articulated Total Body Model Data Set Describing the Large Advanced Dynamic Anthropomorphic Manikin

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Joel Hagan, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAE/ENG/95D-11

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

AL/CFBV
WRight-Patterson AFB OH 45433-7521

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**Joel's efforts were excellent and comprehensive. While we would have done this project if AFIT did not, it would have taken us much longer.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Recent cut-backs in Department of Defense spending have presented a need to augment full-scale ejection seat testing with computer simulation. To this end, the US Air Force's Armstrong Laboratory has developed a data set describing the Advanced Dynamic Anthropomorphic Manikin (ADAM) for use in conjunction with the Articulated Total Body (ATB) model for the purpose of simulating the dynamics of the ADAM during sled track ejections. The purpose of this thesis is to validate the ADAM data set by graphically comparing ADAM joint angular-displacements calculated by the ATB model with those measured during ejection seat sled track tests. The tests used for these comparisons are the ADAM/MASE Integration Tests (AMIT) 79E-G2A and 79E-F1. Results of initial comparisons indicate oversimplifications in original joint resistive torque function calculations. These oversimplifications result in excessive joint oscillations as simulated by the ATB model. A certain amount of success in damping these joint oscillations is realized as a result of modifications to these joint resistive torque functions. Overall, the ATB model accurately simulates ADAM motion for the first 400 milliseconds of each simulation. Beyond this time, simulation versus AMIT 79E-F1 test results correlate relatively well. Nonetheless, excessive oscillations in certain joints continue to persist.

**14. SUBJECT TERMS**

Manikin, ADAM, Ejection Seat, Modeling, Human Body, Ejection

**15. NUMBER OF PAGES**

182

**16. PRICE CODE**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE<br>December 1995 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

Velocity Determination for an Inverted Pseudolite Navigation Reference System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jeffrey M. Hebert

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/95D-06

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

746th Test Squadron
1644 Vandergrift Road
Holloman AFB NM 88330-7850

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

Not only did the thesis contribute to this organization, but by performing this research, the student, Capt Hebert, was able to spin-up on the work done here in half the time.

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** (Maximum 200 words)

As navigation systems continue to improve in performance and features, the Air Force must develop better Navigation Reference Systems (NRS) to keep pace with technology. Specifically, with the advent of enhanced, Integrated Global Positioning System (GPS) and Inertial Navigation Systems (INS) navigators, emphasis is placed on the measuring performance in the presence of GPS jamming. To meet these needs, a new NRS dubbed the Sub-Meter Accuracy System (SARS), is being developed by the 746th Test Squadron, Holloman AFB NM. SARS uses a unique, inverted GPS pseudolite positioning system to determine a reference trajectory. This research investigates two post-processing methods of determining velocity from a discrete position data at a constant data rate. The first method employs numerical differentiation filters to provide noise reduction. The second method uses kinematic model-based Kalman filtering and smoothing to determine the reference velocity

**14. SUBJECT TERMS**

Pseudolite, Velocity, Global Positioning System, GPS Navigation Reference System, SARS, Velocity Determination

**15. NUMBER OF PAGES**
118

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
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| | August 1995 | PhD Dissertation |

**4. TITLE AND SUBTITLE**

Nonlinear Geometric and Material Behavior of Composite Shells with Large Strains

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Scott A. Schimmels, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/95-03

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Nelson Wolf
WL/FIBA
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I would like to thank AFIT, especially Scott and Troy (Faculty Advisor) for the work they did in completing and reporting their research results. I believe investigations of this type form the basis of many successful weapon system development programs, but go "unnoticed" due to their generic nature. We have already used Scott's software to investigate a problem of the TIER II and UAV wing design.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** (Maximum 200 words)

A two-dimensional, geometrically and materially nonlinear shell theory applicable to arbitrary geometries described by orthogonal curvilinear coordinates and encompassing large displacements, moderate rotations for large strain situations has been developed. Additionally, the theory includes Jacobian transformation matrices, based upon displacement parameters, for the Cauchy-2nd Piola-Kirchhoff stress-state and the Cauchy (Almansi) - Green strain-state transformation, and a layered material approach is included for the elasto-plastic analysis to allow for variation of plasticity through-the-thickness. Doubly curved 20, 28, and 36 degree-of-freedom finite elements are defined based on specialization of the nonlinear problems. Post-collapse nonlinear solutions are found through a displacement-control incrementation scheme. This provides solutions to classical von Karman flat plate and Donnell spherical shell equations, intermediate von Karman flat plate and Donnell spherical shell equations, and large displacement and moderate rotational formulations. For deep shells exhibiting large rotations and displacements over 15-20% of the shell's surface, the Langrangian constitutive relations (Including the Jacobian transformation matrices for the stress- and strain-states) should be included to accurately reflect the variation of the material coordinate system with respect to the structural axis system. For those plates and shells exhibiting large strains, along with large rotations and displacements over 15-18% of the outer surface, plasticity should be included in the model.

**14. SUBJECT TERMS**

Composites, Shells, Finite Elements, Nonlinear Analysis, Plasticity, Large Strains, Total Lagrangian, Transverse Shear, Lagrangian-Cauchy Transformation

**15. NUMBER OF PAGES**

477

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1995 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

Mach 2.9 Investigation Into the Flow Structure in the Vicinity of a Wrap-Around Fin

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Richard E. Huffman

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAE/ENY/95D-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Greg Abate
WL/MNAA
Eglin AFB FL

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

I am impressed b the quality of work produced by the student. There was obviously a tremendous amount of effort given to this study. I agree with the conclusions and would like to see the recommendations carried through.... I look forward to seeing follow on work and especially comparisons to CFD efforts.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

A ceiling semi-cylindrical model containing a single wrap-around fin (WAF) was tested in the AFIT Mach 2.9 test facility. Flow visualization using oil-flow streaklines, schlieren images and shadowgraph photography revealed a -shock at the fin-body juncture and the development of an asymmetric bow-shock about the fin. Quantitative measurements were taken with a 10 cone-static pressure probe, a Pitot pressure probe and the two cross-wire hot-film probes (u-v and u-w components, respectively). Measurements were made at cutting-planes from the inlet of the test section to aft of the model, with emphasis placed in the vicinity of the WAF. Results include cutting-plane profiles and contours of mean and turbulent fluctuations of the primitive and conserved flow variables. It was found that the incompressible turbulent fluctuating quantities are equally as descriptive of the flow structure in the fin's vicinity as the compressible turbulence fluctuations. The asymmetric bow-shock was found to be an inviscid phenomenon which was stronger on the concave side than the convex side and deminishing strength at the tip with no bleeding effects over the tip.

**14. SUBJECT TERMS**

Wrap-Around Fins, Supersonic, Wind Tunnel, Turbulence, Hot-Wire Anemometry

**15. NUMBER OF PAGES**

103

**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

A 100 Megahertz Memory Subsystem for the Digital Radio Frequency Memory

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

David H. Kaneshiro

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/95D-09

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Marvin Potts
WL/AAWW-1
Wright-Patterson AFB OH 45433-7765

The results of this thesis effort will be expanded in AAWW inhouse research as well as further AFIT research. A contractual effort to accomplish everything would far exceed $1 million. Capt Kaneshiro made a significant contribution to on-going WL R&D. The speed improvements in the memory design will further improve WL inhouse and contractual efforts. The Advanced Monolithic Digital Radio Frequency Memory (AMDRFM) continues to receive high recognition.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to DoD and DoD contractors only,
Critical Technology. December 1995. Other requests for
this document must be referred to WL/AAWW-1,
Wright-Patterson AFB OH 45433-7318

**13. ABSTRACT** *(Maximum 200 words)*

A 2K by 8 static random access memory was developed for the Digital Radio Frequency Memory. This research continued previous efforts conducted by the Air Force Institute of Technology in the area of Very Large Scale Integration (VLSI). The circuit was fabricated by MOSIS using an 0.8 micron Complimentary Metal Oxide Semiconductor (CMOS) process. New sense amplifier configurations were investigated along with various architectural changes. Improvements were made in the sense amplifiers and various driver circuits to achieve 100 MHz operation. A phase-locked loop was included to provide a clean internal clock which is synchronized to an external reference clock. Precharging was added to the write operation to improve reliability. Recommendations were made regarding future designs for higher speeds.

**14. SUBJECT TERMS**

Digital Radio Frequency Memory, DRFM, Electronic Countermeasures, ECM, VLSI, CMOS, Integrated Circuits, Electronic Warfare, EW, SRAM, Memory, Static Random Access Memory

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**4. TITLE AND SUBTITLE**

Steady-State Kinetics of $Br(^2P_{1/2}) \rightarrow CO_2(101)$ Electronic-to-Vibrational Energy Transfer Laser System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Captain Stephen J. Karis

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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2950 P Street
Wright-Patterson AFB, OH 45433-7765
Advisor: Major Glen Perram

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAP/ENP/95-11

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

PL/LID Dr. E.Dorko & G.D. Hager
3550 Aberdeen Ave SE
Kirtland AFB, NM 87117-6008
POC: E. A. Dorko and G. D. Hager

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

This work defined many potential issues in working with Br transfer lasers-very helpful to us-excellent work

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

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**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

Steady-state photolysis experiments were conducted to gain information relevant to the construction of a continuous-wave electronic-to-vibrational pumped infrared laser. An $Ar^+$ laser ($\lambda = 488$ nm) was used to produce the electronically excited state $Br(^2P_{1/2})$ ($Br^*$) via photolysis of molecular bromine. Energy was then transferred to the near-resonant vibrational state $CO_2(101)$ ($CO_2^\dagger$) via the collisional quenching of $Br^*$ by $CO_2$. The dependence of the 2.71 μm $Br^*$ and 4.3 μm $CO_2^\dagger$ emissions on $CO_2$ pressure was measured, as well as the dependence of the 4.3 μm emission on pump laser chopping frequency. Unexpected results were obtained in both cases, indicating more detailed modeling of kinetic processes is called for. Additionally, an unexplained long-term decay in the 4.3 μm signal was observed, which may have bearing on the construction of closed-system laser devices. Recommendations are made for further research.

**14. SUBJECT TERMS**

photolysis of $Br_2$, E-V transfer, gas laser kinetics, $Br^*$:$CO_2$ laser

**15. NUMBER OF PAGES** 105

**16. PRICE CODE**

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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Methodology for Implementing Fracture Mechanics in Global Structural Design of Aircraft

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Clifton D. Nees, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Capt Cliff Nees did an excellent job. Our goal is to bring detailed design issues into the preliminary design. This thesis established the feasibility of such an approach. Very useful in our multi-disciplinary research work.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**13. ABSTRACT** *(Maximum 200 words)*

The analysis and design criteria of fracture mechanics are investigated for implementation with the Automated Structural Optimization System (ASTROS) global optimization design tool. The main focus is the optical design of aircraft wing panels by applying fracture mechanics design criteria with the global finite element model. This effort consists of four main phases: investigation of fracture mechanics analysis methods and design criteria, formulation of a computational technique for damage tolerance design consistent with global optimization requirements, integration of the technique into the ASTROS design tool, and demonstration of the results.

**14. SUBJECT TERMS**

Fracture Mechanics, Fatigue, Damage Tolerance, Aircraft Optimization, Wing Panel Design, Local Modeling, Global Modeling

**15. NUMBER OF PAGES**

122

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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Influence of a Moving Endwall on the Tip Clearance Vortex in an Axial Compressor Cascade

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Lawrence J. Peter

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. W. Copenhaver
WL/POTF
Wright-Patterson AFB OH 45433

**11. SUPPLEMENTARY NOTES**

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This is an excellent piece of work and begins to answer some very significant questions in compressor design approaches. The following comments are recommendations on future research topics: A. Blade loading levels need to be higher, effect moving hubs would have on these types of stators…Effects of the moving wall are minimal if clearance levels are small. Is this conclusion universal with higher loadings. Crenulations may be of interest in the future…another topic of interest related to transonic rotors in Shock-Tip Vortex interaction…potential AFIT involvement?

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**13. ABSTRACT** (Maximum 200 words)

This experiment involved the design, construction, validation and testing of a new facility for the investigation of vortices generated by compressor rotor blade tip clearance with a moving endwall. A five-tube pressure take placed downstream of the trailing edge of a cascade of blades measured the pressure field for flow coefficients ranging from 20 to 1.66 and tips clearances of 0.33, 1.0, 1.7, and 2.4 percent chord. Contour plots of mass averaged pressure loss coefficient appear to show the no-flow tip vortex becomes entrained and diffused by the moving wall boundary layer. The high loss region near the moving wall contracts toward and extends toward the pressure side of the adjacent blade. This contraction results in a reduction in overall blockage in the passage with a corresponding reduction in passage losses, toward an apparent steady-state value, for increasing end wall speed and decreasing tip clearance.

**14. SUBJECT TERMS**

Axial Flow Compressor Blades, Cascades, Compressor Losses, Crenulations, Secondary Flow, Tip Clearance, Vortices

**15. NUMBER OF PAGES**

137

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**4. TITLE AND SUBTITLE**

IDENTIFICATION OF MOLECULAR LASER TRANSITIONS
USING THE FINITE ELEMENT METHOD

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Matthew C. Smitham, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAP/ENP/95D-14

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Kirtland Air Force Base NM 87117-5776

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Excellent work! It's this kind of work that makes AFIT shine!

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

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**13. ABSTRACT (Maximum 200 words)**

This thesis is a continuation of a previous effort which developed a finite element solution of Schrödinger's Equation. Identification of laser transition rates can be obtained by solving Schrödinger's Equation for diatomic molecules using the finite elements method. Experimental vibrational eigenvalues for a given electronic state are used to determine the molecular potential surface which yields the closest numerical result. A non-linear minimization routine is used to hunt for this surface by adjusting parameters of energy functions such as the Harmonic, Morse, Lennard-Jones, and Mie potentials. The eigenvalues from these solutions are then compared to the experimental values. Through this iterative process, the best potential surface is isolated. Franck-Condon factors are then computed with the numerical eigenfunctions from two different potential surfaces found in this way. This numerical technique was able to isolate potential surfaces whose eigenvalue solutions had relative errors better than $10^{-3}$ and $10^{-6}$ percent when compared to the analytical solutions of the Harmonic and Morse oscillators, respectively. Comparisons of the wavefunctions also yielded excellent agreement. Initial work with $H_2$ $(X\ ^1\Sigma_g^+)$ verifies the lower eigenstates can be approximated by the Morse potential with an anharmonicity term of 1.0912 inverse a.u. and a dissociation energy of 0.177 Hartrees.

**14. SUBJECT TERMS**

Laser, Diatomic, Molecules, Spectroscopy

**15. NUMBER OF PAGES**
114

**16. PRICE CODE**

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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Analysis and Interpretation of Ion Data Associated with Neutral Gas Releases in the Earth's Ionosphere

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Tim Shadid, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAP/ENP/95D-12

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Don E. Hunton
PL/GPID
Hanscom AFB MA 01731

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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I enjoyed my interaction/collaboration with AFIT faculty and students and hope to continue.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

Barium and strontium release experiments were conducted throughout 1991 from the Combined Release and Radiation Effects Satellite (CRRES) to study both natural and man-made disturbances in the earth's ionosphere. A mass spectrometer on the spacecraft counted the Ba and Sr ions as the cloud expanded. In this study, data from the G-1 (in sunlight) and G-11b (in darkness) releases were modeled to understand the source of the ion signals. The model reproduced the Ba sun data well assuming photoionization ( = 28 s) was the primary ionization mechanism. However, it was not able to account for the remaining ion data: (a) Sr has a very long phtoionization time constant ( = 1920 s) and model/data comparisons showed that the Sr ionization rate must be 60 times greater than the phtoionization rate to account for the observed signals, (b) The charge transfer ionization process between Sr/Ba and ambient O was not sufficient to reproduce the ionization rates for Sr sun data and Sr/Ba dark data. Processes potentially responsible for the CRRES data include charge stripping and critical velocity ionization (CIV). Split peaks in the ion data were also investigated and found to be due to either an instrument sensitivity feature or a two-process mechanism.

**14. SUBJECT TERMS**
CRRES, Ionosphere, Barium, Strontium, Charge Exchange, Photoionization, Charge Stripping, Charge Stripping, Electron Impact, Critical Ionization Velocity

**15. NUMBER OF PAGES**
146

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
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| | September 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Non-Imaging Infrared Spectral Target Detection

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Matthew R. Whitely, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAP/ENP/95S-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Scott A. Sallberg
WL/AARI
Wright-Patterson AFB OH 45433-7408

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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We greatly appreciate the excellent research and hope to continue this work as Capt Whiteley and Maj Roggemann continue to investiate multispectral target detection during Capt Whiteley's pusuit of the PhD under Major Roggemann's direction.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

Automatic detection of time-critical mobile targets using spectral-only infrared radiance data is explored. A quantification of the probability of detection, false alarm rate, and total error rate associated with this detection process is provided. A set of classification features is developed for the spectral data, and these features are utilized in a Bayesian classifier. The results of this processing are presented and sensitivity of the class separability to target set, target configuration, diurnal variations, mean contrast, and ambient temperature estimation errors is explored. This work introduces the concept of *atmospheric normalization* of classification features, in which feature values are normalized using an estimate of the ambient temperature surrounding the target. Classification testing of spectral field measurements made on an array of US and foreign military assets reveal a total error rate near 5% with a 95% probability of detection and a concurrent false alarm rate of 4% when a single classification feature is employed. Sensitivity analysis indicates that the probability of detection is reduced to 70-75% in the hours preceding daylight, and that for the total error rate to be less than 10%, the target-to-background mean contrast must be greater than 0.1. Analysis of the atmospheric normalization technique reveals that in order to keep the total error rate less than 10%, the ambient temperature must be estimated with less than 3K absolute accuracy.

**14. SUBJECT TERMS**

Multispectral, Spectral, Infrared, Target Detection, Critical Mobile Targets, Remote Sensing, Radiometry, Pattern Recognition, Bayesian Classifier

**15. NUMBER OF PAGES**

120

**16. PRICE CODE**

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# REPORT DOCUMENTATION PAGE

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Effects of Base Cavity Depth on a Free Spinning Wrap-Around Fin Missile Configuration

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jon A. Struck

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAE/ENY/95D-22

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Gregg Abate
WL/MNAA
Eglin AFB FL

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

I agree with the students recommendations. Although the reduction in drag is not at the levels of the STRIX results or those of Morel and Compton, definite reductions were seen. Now we should do detailed studies, as recommended by the student, to support the theories of why this happens. Perhaps even some CFD simulations would shed some insight into this phenomena. I would suspect that one would need a full 3D Navier-Stokes code.
Again, I think the student did an excellent job in analysis and experiments and hopefully we can build on this work by exploring Some of the theories in greater detail.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

This study investigates the role base cavity depth plays in altering the overall subsonic aerodynamic forces on a free spinning axisymmetric body with wrap-around fins. Wind tunnel usage allowed the forces to be monitored for varying base cavity depths and angles of attack. A base cavity depth analysis was also performed on a non-spinning axisymmetric body for comparison. Oil flow visualizations were conducted on the non-spinning configuration to further describe airflow patters around the body and within the cavity. Results revealed that the aerodynamic forces, mostly drag, changed with increasing cavity depth but not to the extent previously believed. The force results, in conjunction with the flow visualizations, suggested that base cavities have very similar effects on spinning and non-spinning missile configurations.

**14. SUBJECT TERMS**

Base Cavity Effects, Wrap-Around Fins, Free Spinning Missile, Subsonic Wind Tunnel Testing

**15. NUMBER OF PAGES**

157

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| Unclassified | Unclassified | Unclassified | UL |

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Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE<br>September 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br>*ASSESSING USER REQUIREMENTS FOR AN AUTOMATED SYSTEM TO SUPPORT PROGRAMMED DEPOT MAINTENANCE THROUGH THE USE OF A RAPID PROTOTYPE IN A GROUP SUPPORT SYSTEM ENVIRONMENT* | | **5. FUNDING NUMBERS** | |
| **6. AUTHOR(S)**<br>Floyd A. Gwartney, Captain, USAF | | | |
| **7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)**<br><br>Air Force Institute of Technology<br>2750 P Street<br>WPAFB OH 45433-7765 | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GTM/LAR/96S-7 | |
| **9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>OL AL HSC/HRGO<br>Attn: Ms. Barbara Masquelier<br>2698 G Street<br>WPAFB, OH 45433-7604 | ASSESSMENT BY ABOVE SPONSOR = | Results from thesis research will be used to guide development of advanced human computer interface for depot-level maintenance system. Research represents first use groupware for evaluation of human computer interface. Research helped ITI-ALC program. | |
| **11. SUPPLEMENTARY NOTES** | | | |
| **12a. DISTRIBUTION / AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | | **12b. DISTRIBUTION CODE** | |

**13. ABSTRACT (Maximum 200 Words)**

The purpose of this thesis was to assess user requirements for an automated information system to support programmed depot maintenance (PDM). To accomplish this, the Integrated Technical Information for the Air Logistics Centers (ITI-ALC) program's rapid prototype was evaluated. The evaluation focused on users' perception of how well the prototype met system and human computer interface requirements for PDM technicians and managers. A group support system (GSS) was used as an analysis tool to evaluate the prototype and collect evaluation data. Using the prototype as a requirements baseline for the ITI-ALC system, this thesis had three objectives: to perform an assessment of the prototype and illicit modifications; to determine prototype compatibility with user's needs; and to investigate using GSS for prototype analysis. A total of seven users composed of PDM technicians and supervisors evaluated the prototype by following a scenario, and documenting their ideas using the GSS. Results indicate the prototype functionally meets user's requirements, however suggested modifications to enhance the prototype and gain more user acceptance. Results also indicate that a GSS is effective and efficient for performing prototype analysis. The primary recommendation was to make suggested changes and perform further tests to refine the ITI-ALC system baseline.

| **14. SUBJECT TERMS**<br>Prototypes, User Needs, Decision Support Systems, Interfaces, Requirements, Aircraft Maintenance, Maintenance Management, Management Information Systems, Automation, Information Systems | | **15. NUMBER OF PAGES**<br>182 | |
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| I. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE September 1996 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
|---|---|---|---|

| 4. TITLE AND SUBTITLE INFORMATION REQUIREMENTS ANALYSIS: A QUALITATIVE CHARACTERIZATION OF THE FLIGHTLINE EXPEDITER FOR THE INTEGRATED MAINTENANCE INFORMATION SYSTEM | | 5. FUNDING NUMBERS |
|---|---|---|
| 6. AUTHOR(S) John C. Gorla, Jr., Captain, USAF | | |

| 7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)  Air Force Institute of Technology 2950 P Street WPAFB OH 45433-7765 | 8. PERFORMING ORGANIZATION REPORT NUMBER   AFIT/GLM/LAR/96S-3 |
|---|---|

| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)  Barbara L. Masquelier, System Engineer Operational Logistics Branch, Armstrong Laboratory WPAFB OH 45433-6503 | 10. SPONSORING / MONITORING AGENCY REPORT NUMBER  **Research will be passed to implementers of IMIS concept. Research will be used as foundation of in-house software development. The results will also be transitioned to SSC. SSC has program underway to automate information requirements.** |
|---|---|
| 11. SUPPLEMENTARY NOTES  ASSESSMENT BY ABOVE SPONSOR = | |

| 12a. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution unlimited | 12b. DISTRIBUTION CODE |
|---|---|

13. ABSTRACT (Maximum 200 Words)

The Integrated Maintenance Information System (IMIS) concept design includes the addition of management tools to access IMIS databases and provide communication capabilities between flightline technicians and supervisors. Armstrong Laboratory has developed a portable maintenance aid for technicians, and sponsored this research to investigate the requirements for a computer-based tool for the expediter. The basic hardware and software requirements document for IMIS, the System/Segment Specification (SSS), contains task information that closely corresponds to the expediter job description as defined in Air Combat Command Instruction 21-166. This research compiled a list of information requirements for the expediter from the IMIS SSS and analyzed the resulting information using subjective evaluation and theoretical foundations in linguistics. The results support the notion that the expediter is often an intermediary to maintenance information. The recommendations focused on freeing the expediter to do more important tasks by re-engineering the information flow in IMIS, which could result in significant workload reductions for the expediter with proper design of the information processes in an IMIS context.

| 14. SUBJECT TERMS Integrated Maintenance Information System  IMIS  Human Computer Interface  Maintenance Information Management Information Systems  Military Requirements  Language  Speech  Semantics | | | 15. NUMBER OF PAGES 106 |
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| | | | 16. PRICE CODE |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | September 1996 | Doctoral Dissertation |

**4. TITLE AND SUBTITLE**

Numerical Analysis of Two and Three Dimensional Recessed Flame Holders for Scramjet Applications

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

D. L. Davis

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/96-12

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Parker Buckley
WL/POPS
Wright-Patterson AFB OH 45433-7251

Flame holding is a key limiting factor in the development of supersonic combustion ramjet engines. The recessed cavity flame holder design that Doug developed and analyzed has enormous potential, and the concept is currently being experimentally evaluated in Test Cell 22 at WPAFB. Furthermore, the flame holder design methodology that was developed in Doug's dissertation is currently being used by Air Force scientists and engineers in the scramjet development program. If performed under contract, this research would have cost our organization over $400,000. However, the positive impact to the division mission is far more valuable.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This study investigated the flame holding properties of recessed cavities in supersonic flow using numerical analysis techniques. A simplified analytical model indicated that an important property for flame holding was the lower residence time. Several chemical kinetics rate models for hydrogen and hydrocarbon combustion were compared. The perfectly stirred reactor model also indicated that trace species diffusion should increase flame spreading rate, and that heat loss reduces flame holding limits. After nonreacting calibration, two-dimensional simulations confirmed the perfectly stirred reactor results for blowout limits. Also, the effect of trace species diffusion on flame spreading was shown to be negligible, and the reduced flammability with heat loss was confirmed. Lowering the temperature of the inflow boundary layer was shown to reduce the flammability limits. Three-dimensional cavities were shown to generate axial vorticity and slightly enhance flame spreading. The methodology developed in this research provides a design guide for the size of cavity required to provide flame holding for scramjet combustor. Also, reduction of heat losses was shown to be a method to improve flame holding performance without increasing the cavity size.

**14. SUBJECT TERMS**

Scramjet, Flame Holder, Combustion, Stirred Reactor

**15. NUMBER OF PAGES**

236

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|---|---|---|
| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Artificial Cochlea Using Micro-Electro-Mechanical Systems

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

George C. Dalton II, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCS/ENG-96D-06

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Adrian Michalicek
PL/VTEE
Kirtland AFB NM 87117-5776

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = 　**AFIT Members research is outstanding**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

The use of Micro-Electro-Mechanical Systems (MEMS) in the design of an artificial cochlea is investigated in depth. Interdigitated finger (comb), cantilever, bridge, and mirror resonators are presented as possible devices used to implement the artificial cochlea. These resonators are demonstrated to be extremely high Q devices, capable of being tuned with a simple DC bias. This suggests a change to existing cochlea models that claim highly complex AC feedback as being responsible for changes in the dampening of the basilar membrane. The new cochlea model presented here, using MEMS to approximate the tuning of the basilar membrane, may be closer to the workings of the actual cochlea, as we understand it today.

**14. SUBJECT TERMS**

Micro-Electro-Mechanical Systems (MEMS), Artificial Cochlea, MEMS cochlea, Interdigitated Finger (comb), Cantilever, Bridge, Mirror, Resonators

**15. NUMBER OF PAGES**

208

**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

Non-Linear Finite Element Analyses of Composite Shells by Total Lagrangian Decomposition with Application to the Aircraft Tire

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

James M. Greer, Jr.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/96-1

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Arje Nachman          Dr. Arnold Mayer
AFOSR/NM                  WL/FIV
Bolling AFB DC 20332       Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**Substantive contribution to development of pubic domain (non-proprietary) Tire Dynamics analysis capability.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

A total Lagrangian finite element scheme for arbitrarily large displacements and rotations is applied to a wide range of shell geometries. The Jaumann stress and strain measures, which are resolved along the axes of an orthogonal triad rigidly rotated and translated with the deforming structure, are employed in the algorithm. Layer-wise higher-order shear warping and thickness stretch effects are included in the model. Two finite elements are employed in the analyses: an eight-noded, 36 degree-of-freedom (DOF) element, and a four-noded, $C^1$ continuous, 44 DOF element. The 36 DOF element proves adequate for moderate rotation problems, but fails in modeling very large rotation problems. The use of the 44 DOF element provides dramatically improved results the the large rotation problem. Isotropic and anisotropic beams, plates, arches, and shells are analyzed. An aircraft tire is also analyzed using the model with regard to deformations resulting from the inflation pressure, and the flexibility of static contact analysis is also demonstrated.

**14. SUBJECT TERMS**

Nonlinear Analysis, Finite Elements, Composites, Shell Theory, Tires, Shear Deformation, Thickness Stretching, Contact

**15. NUMBER OF PAGES**
324

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
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| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Evaluation of Design Tools for Rapid Prototyping of Parallel Signal Processing Algorithms

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

James C. Savage, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Robert Ewing
WL/AASH
Wright-Patterson AFB OH 45433-7319

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = Thesis advisor and student did an excellent job!

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

A DSP application of interest to the Air Force is high-speed avionics processing. The real-time computing requirements of avionics processing exceed the capabilities of current single-chip DSP processors, and parallelization of multiple DSP processors is a solution to handle such requirements. Designing and implementing a parallel DSP algorithm has been a lengthy process often requiring different design tools and extensive programming experience. Through the use of integrated software development tools, rapid prototyping becomes possible by simulating algorithms, generating code for workstations or DSP micoprocessors, and generating hardware description language code for hardware synthesis. This research examines the use of one such tool, the Signal Processing Work System (SPW) by the Alta Group of Cadence Design Systems, Inc., and hardware implementation. Throughout this process, SPW is evaluated as an aid to the avionics designer to meet design objectives and evaluate trade-offs to find the best blend of efficiency and effectiveness. SPW is shown to be a viable rapid prototyping solution allowing an avionics designer to focus on design trade-offs instead of implementation details while using parallelization to meet real-time application requirements.

**14. SUBJECT TERMS**

Digital Signal Processing, Parallel Processing, Electronic Design Automation, Multidimensional Fast Fourier Transform

**15. NUMBER OF PAGES**

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**16. PRICE CODE**

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|---|---|---|

**4. TITLE AND SUBTITLE**

Design and Simulation of a Transform Domain Communication System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Rodney A. Radcliffe, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/96D-16

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

James P. Stephens
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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

This research will help shape future directions in parameter identification necessary for reconfigutable flight systems

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

A proposed transform domain communications system is shown to provide significant jamming protection over a wide range of jamming conditions. The proposed system samples the local environment to determine the presence and spectral location of jamming signals. Transform domain signal processing techniques are use to design a waveform such that the jammed frequencies are avoided. This wave form is stored in memory and modulated by several techniques. At the receiver, the signal is correlated with a locally generated version of the waveform and data is retrieved. The proposed system is simulated using MATLAB® and the results analyzed for comparison to a baseline of a binary phase shift keying (BPSK) direct-sequence spread spectrum system. The performance measure used is probability of bit error, $P$. The transform domain system provided significant jamming protection over the direct-sequence system for a wide range of jamming conditions. For a signal bit energy to noise PSD level ($E_b/N_o$) of 4 dB and a variety of jamming conditions, antipodal signal modulation provided an average improvement of 12.7 dB and a binary orthogonal signal modulation provided a 6.8 dB improvement. $M$-ary orthogonal signal modulation is successfully signal modulation is successfully demonstrated and shown to provide increasing improvement with an increasing number of signals in the signal set.

**14. SUBJECT TERMS**

Transform Domain, Spread Spectrum, Spectral Shaping, Jamming Suppression

**15. NUMBER OF PAGES**

119

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| | 2 December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Utilizing Bayesian Techniques for User Interface Intelligence

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert A. Harrington, 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Abraham Waksman
AFOSR/NM
Bolling AFB DC 20332

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = Very well executed and disciplined research. Nice Work!

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

The purpose of this research is to study the injection of an intelligent agent into modern user interface technology. This agent is intended to manage the complex interactions between the software system and the user, thus making the complexities transparent to the user. The background study will show that while interesting and promising research exists in the domain of intelligent interface agents, very little research has been published that indicates true success in representing the uncertainty involved in predicting user intent. The interface agent architecture presented in this thesis will offer one solution for solving the problem using a newly developed Bayesian-based agent called the Intelligent Interface Agent (IIA). The proof of concept of this architecture has been implemented in an actual expert system, and this thesis presents the results of the implementation. The conclusions of this thesis will show the viability of this new agent architecture, as well as promising future research in examination of cognitive models, development of an intelligent interface agent interaction language, expansion of meta-level interface learning, and refinement of the PESKI user interface.

**14. SUBJECT TERMS**

Intelligent User Interface, Generic Expert System, Uncertainty-based Reasoning, Bayesian Network

**15. NUMBER OF PAGES**

93

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis |
|---|---|---|

| 4. TITLE AND SUBTITLE<br><br>Residual Strength and Fatigue Characterization of SCS-6/TI-6-4 | 5. FUNDING NUMBERS |
|---|---|

| 6. AUTHOR(S)<br><br>Sang-Myung Lee, Maj, ROKA | |
|---|---|

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | 8. PERFORMING ORGANIZATION REPORT NUMBER<br><br>AFIT/GAE/ENY/96d-7 |
|---|---|

| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br><br>Dr. Theodore Nicholas<br>WL/MLLN<br>Wright-Patterson AFB OH 45433-6583 | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER |
|---|---|

11. SUPPLEMENTARY NOTES  ASSESSMENT BY ABOVE SPONSOR =

**This project contributed to a large effort in ML in characterization of metal matrix composites and provided useful information on fatigue damage mechanisms**

12a. DISTRIBUTION AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

13. ABSTRACT *(Maximum 200 words)*

This study investigated the residual strength of unidirectional laminate of SCS-6/Ti-6-4, a titanium alloy matrix based composite at elevated temperature 427 C under tension-tension load controlled mode ($\sigma_{max}$=900MPa, R-ratio=0.05) with 1Hz and 0.01Hz frequencies. Two specimens were tested for a ultimate tensile strength and modulus of the materials and then were fatigued to failure. Based on the strength and fatigue life, specimens were fatigued to various fractions of the fatigue life and then loaded monotonically to failure. Macroscopic and microscopic observation were performed to characterize damage. Under both 1Hz and 0.01Hz test frequencies, the residual strength degraded so slowly up to 70-90% of the fatigue life and then dropped catastrophically to the end of the life. The critical failure behavior revealed in this material was able to be banded by the maximum and minimum curve so that most variation of the residual strength could be included within thse ranges.

| 14. SUBJECT TERMS<br><br>Metal-matrix composite (MMC), Residual Strength, Frequency Effects, SCS-6/Ti6-4, Isothermal Fatigue, Fiber Cracks, Matrix Crack, Creep | 15. NUMBER OF PAGES<br>122 |
|---|---|
| | 16. PRICE CODE |

| 17. SECURITY CLASSIFICATION OF REPORT<br><br>Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE<br><br>Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT<br><br>Unclassified | 20. LIMITATION OF ABSTRACT<br><br>UL |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

Clustered Microcalcification Detection Using Optimized Difference of Gaussians

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Edward M. Ochoa, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEO/ENG/96D-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj. Jeffrey W. Hoffmeister, MD
AL/CFAHV
Wright-Patterson AFB OH 45433-7022

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**Excellent thesis. Will impact Computer-Aided Diagnosis of Breast Cancer significantly.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Clustered microcalcifications are one of the earliest indicators of breast cancer, and are detected only by mammography; 30 to 50 percent of nonpalpable cancers are mammographically visible on the basis of microcalcifications alone. Furthermore, for early breast cancers, screening studies suggest that 70 to 90 percent were detected based on microcalcifications alone. This research proposes the following methodology for clustered microcalcification detection. First, preprocess the digitized film mammogram to reduce digitization noise. Second, spatially filter the image with a difference of Gaussians (DoG) kernel. To detect potential microcalcifications, segment the filtered image using global and local thresholding. Next, cluster and index these detections into regions of interest (ROIs). Identify ROIs on the digitized image (or hardcopy printout) for final diagnosis. Finally, to improve detection rates, globally optimize detection parameters using a genetic algorithm (GA), then locally optimize using the simplex method. The data base of 56 digitized (12 bit, $100 \mu m$) full-breast ($20 \times 10$ cm$^2$) film mammograms contained 63 biopsy-truthed clustered microcalcification ROIs over 28 cases. This technique demonstrated a true positive (TP) case detection rate of 96.4 percent (27/28), and TP ROI (54/63) and TP image (48/56) detection rates of 85.7 percent with 5.75 false positives (FPs) per full-breast image.

**14. SUBJECT TERMS**

Pattern Recognition, Breast Cancer, Clustered Microcalcifications, Medical Imagining, Genetic Algorithms, Difference of Gaussians

**15. NUMBER OF PAGES**
97

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| Unclassified | Unclassified | Unclassified | UL |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>March 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br><br>Modeling Diminishing Marginal Returns: An Application to the Aircraft Availability Model | | **5. FUNDING NUMBERS** | |
| **6. AUTHOR(S)**<br><br>Wayne L. Zorn, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | **8. PERFORMING ORGANIZATION**<br>**REPORT NUMBER**<br><br>AFIT/GAO/ENS/96M-10 | |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>AFMC/SAO<br>Wright-Patterson AFB OH 45433-5006 | | **10. SPONSORING/MONITORING**<br>**AGENCY REPORT NUMBER** | |

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

This work provides a good foundation for an area of projects we would like to explore. Parts of this work will be incorporated into our future projects.

| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

The Aircraft Availability Model (AAM) provides the Air Force with a worldwide peacetime requirement for reparable spare parts. This research models AAM methodology as it relates to the concept of deminishing marginal returns in resource application. Three separate modeling techniques are investigated with the foal of reformulating the AAM as a mathematical programming model that provides a comparable solution and a capable tool for the conduct of sensitivity analysis. The general formulations presented here are continuous non-linear, continuous linear, and piecewise linear discrete/continuous models. Two formulations of the piecewise linear discrete/continuous model are presented. The piecewise linear model based on AAM sort values shows the dominance of an optimization routine relative to the AAM shopping list greedy heuristic. The piecewise linear model based on availability rates provides the capability to maximize the mission design series (MDS) availability level. It has the potential to obtain the highest possible MDS availability relative to reparable spares inventory levels. This mathematical model is discussed in complete detail as a robust platform for conducting extensive post-optimality analysis.

| 14. SUBJECT TERMS<br><br>Reparable Spares; Aircraft Availability; Linear Programming | | | 15. NUMBER OF PAGES<br>131 |
|---|---|---|---|
| | | | 16. PRICE CODE |
| 17. SECURITY CLASSIFICATION<br>OF REPORT<br>Unclassified | 18. SECURITY CLASSIFICATION<br>OF THIS PAGE<br>Unclassified | 19. SECURITY CLASSIFICATION<br>OF ABSTRACT<br>Unclassified | 20. LIMITATION OF<br>ABSTRACT<br>UL |

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# REPORT DOCUMENTATION PAGE

| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE September, 1996 | 3. REPORT TYPE AND DATES COVERED Dissertation |
|---|---|---|

**4. TITLE AND SUBTITLE**
Electromagnetic Scattering from Semi-Infinite Planar Arrays

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
Peter J. Collins

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Air Force Institute of Technology, WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**
AFIT/DS/ENG/96-06

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
Dr. Brian Kent
WL/XPN
WPAFB, OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**
ASSESSMENT
BY
ABOVE SPONSOR =

We appreciate Pete's work. We look forward to working with AFIT/ENG in the future. Certainly, we should point out in the event AFIT closes, Pete Collins would be a welcome addition to our organization.

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**
Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**
A hybrid method of moments (MM) based numerical model for the electromagnetic scattering from large finite by infinite planar slot arrays is developed. The method incorporates the novel concept of a physical basis function (PBF) to dramatically reduce the number of required unknowns. The model can represent a finite number of slot columns with slots oriented along the infinite axis, surrounded by an arbitrary number of coplanar dielectric slabs. Each slot column can be loaded with a complex impedance, allowing one to tailor the edge currents to provide a desired echo width pattern. The surface equivalence theorem is used to convert the original slotted ground plane geometry to an equivalent unbroken ground plane with magnetic surface currents. An integral equation based on these magnetic scattering currents is solved via the MM. The magnetic currents are approximated by a set of basis functions composed of periodic basis functions representing the edge slot columns and a single PBF representing the interior slot columns. In particular, the PBF captures the behavior of the central portion of the array where the perturbations from the edges have become negligible. Based on Floquet's theorem, the PBF is able to represent an arbitrarily large number of slot columns with just one unknown. The array scanning method (ASM) provides the contributions from the individual edge columns. Finally, a newly developed one-sided Poisson sum formulation provides an efficient means to account for the stratified dielectric media via a spectral domain conversion. The hybrid method is validated using both MM reference codes and measured data. The results clearly demonstrate the method's accuracy as well as its ability to handle array problems too large for traditional MM solutions.

**14. SUBJECT TERMS**
Periodic Array, Frequency Selective Surface, Electromagnetic Scattering, Hybrid Method of Moments

**15. NUMBER OF PAGES**
182

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| UNCLASSIFIED | UNCLASSIFIED | UNCLASSIFIED | UL |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

An intelligent Spread Spectrum Jammer

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert S. Parks, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/96D-15

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. James P. Stephens
WL/AAMW
Wright-Patterson AFB OH

I greatly appreciated how Rob kept me informed on at least a monthly basis regarding his research status. This helped focus his work in the area where I was most interested. I found his work to be extremely relevant, significant and useful for the activities of the Electronic Combat Branch, RF Technologies Division, Avionics Directorate, Wright Laboratories. The relationships established with AFIT students and faculty by Wright Lab engineers and scientists have been valuable funds/manpower multipliers very necessary in today's environment of downsizing. This is especially true when the research results are of such superior quality as provided by Capt Parks.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to DoD and DoD contractors only. Requests for this document must be referred to WL/A/ Wright-Patterson AFB OH 45433

**13. ABSTRACT** *(Maximum 200 words)*

Not available

**14. SUBJECT TERMS**

Jammers, Intelligent Jammers, Spread Spectrum

**15. NUMBER OF PAGES**

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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|---|---|---|
| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Development of Synthetic Soils for Sorption Mass Transfer Model Validation

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Thomas P. de Venoge, Capt, USAF, BSC

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEE/ENV/96D-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Mike Chipley
AFOSR/NA
Bolling AFB DC 20332

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = I find AFIT faculty and students to be an extremely valuable resource and a very cost effective research effort.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** (Maximum 200 words)

Existing sorption models often fail to describe grain scale sorption because of an inability to define the diffusion domain. A proposed improved model required testing to determine model validity. The testing method used a synthetic media of known geometry such that the distribution of sorption sizes was known. Sorption rate data was obtained using batch experiments with the media. Data was used in comparison against model predicted rates. Fitted sorption size distributions were compared to real distributions obtained by controlling sorbent geometries. Comparison determined model performance in fitting known distributions. The focus of this study was to, 1) determine what protocols are necessary to ensure consistent chemical and physical properties of a synthetic media for sorption studies, 2) determine if the proposed model can predict the known shape parameters describing the frequency distribution of sorption sites by using the rate data obtained from sorption studies, and 3) validate the model. Model performance was encouraging for simultaneous fitting of two shape parameters. Simulations resulted in sorption site distributions similar to the known distributions. This model is an improvement over other diffusion models where geometries are assumed to be spherical. Prediction of real soil sorption site distributions may be possible.

**14. SUBJECT TERMS**

Sorption, Nonequilibrium, Rate Limited, Fate and Transport, Groundwater, Contamination, Remediation, Environment, Modeling, Diffusion, Soil

**15. NUMBER OF PAGES**

113

**16. PRICE CODE**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE December 1996 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
|---|---|---|---|
| 4. TITLE AND SUBTITLE A Size and Power Efficient High Performance Multiplier for Real Time DSP Applications | | | 5. FUNDING NUMBERS |
| 6. AUTHOR(S) Javier Marti | | | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Institute of Technology Wright-Patterson FEB OH 45433-7765 | | | 8. PERFORMING ORGANIZATION REPORT NUMBER AFIT/GCS/ENG/96D-18 |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Marvin N. Potts WL/AAMW Wright-Patterson AFB OH 45433-7333 | | | |

ASSESSMENT
BY
ABOVE SPONSOR =

This thesis project was part of an ongoing program at Wright Laboratory. The research performed by Capt Marti was highly significant to the continuation of the program. The high performance multipliers are needed as subcomponents to an advanced digital electronic warfare system. Without the advancement established by Capt Marti's research, WL would not be able to meet performance requirements.

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution Authorized to DoD & DoD contractors only; Critical technology

**13. ABSTRACT** *(Maximum 200 words)*

This research continues previous efforts conducted by the Air Force Institute of Technology in the area of Very Large Scale Integration (VLSI). These efforts are directed by the Electronic Countermeasures Branch of the Wright Laboratory Avionics Directorate and are aimed at increasing the operational speed of a digital radio frequency memory (DRFM) with an internal digital single-sideband modulator (DSSM). A two's complement multiplier for a DSSM was fabricated by MOSIS using a 0.8 micron Complementary Metal Oxide Semiconductor (CMOS) process. The design relies heavily on the use of pass transistor logic (PTL). It incorporates a variant of the Baugh-Wooley algorithm with the use of a 5:3 counter. The carry propagate addition is performed by a carry chain select adder. The multiplier is able to achieve operational speeds in excess of 125 MHz.

| 14. SUBJECT TERMS Digital Radio Frequency Memory, Digital Single-Sideband Modulation Parallel Multiplication, Two's Complement Multiplication, Pass Transistor Logic | | | 15. NUMBER OF PAGES 100 |
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| | | | 16. PRICE CODE |
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UL |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE <br> December 1996 | 3. REPORT TYPE AND DATES COVERED <br> Master's Thesis | |
|---|---|---|---|
| **4. TITLE AND SUBTITLE** <br><br> Performance Analysis of a Liquid Metal Heat Pipe Space Shuttle Experiment | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)** <br><br> Timothy J. Dickinson, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)** <br><br> Air Force Institute of Technology <br> Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER** <br><br> AFIT/GAE/ENY/96D-2 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)** <br><br> Marko M. Stoyanof <br> PL/VTVS <br> Kirtland AFB NM 87117-5776 | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

Outstanding work! I am very pleased with the technical quality of the work/thesis. This will be used as the final report to close out this activity.

| **12a. DISTRIBUTION AVAILABILITY STATEMENT** <br><br> Approved for public release; distribution unlimited | **12b. DISTRIBUTION CODE** |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

Future spacecraft technologies require advanced high-temperature thermal control systems. Liquid metal heat pipes are ideally suited for such applications. However, their behavior during microgravity operation is not yet understand. This study investigated liquid metal heat pipe performance in such an environment. Three stainless steel/potassium heat pipes were flown on space shuttle mission STS-77 in May 1996. The objectives of the experiment were characterization of the frozen startup and restart transients, comparison of flight and ground test data, and assessment of three different heat pipe designs. Heat pipe performance was characterized prior to the flight experiment. Predicted performance envelopes for each heat pipe were determined from theoretical calculations. Performance baselines were established from ground thermal vacuum test results. These pre-flight results were compared with those from the flight experiment. Thermal resistances were calculated for each heat pipe design. Microgravity operation did not adversely impact the startup or restart behavior of the heat pipes. The heat pipes operated within the predicted performance envelopes. The three designs had distinct startup characteristics yet similar steady-state performance. These results will serve as a benchmark for further liquid metal heat pipe studies and space system applications.

| **14. SUBJECT TERMS** <br><br> Heat Pipe, Liquid Metal, Space Experiment, Thermal Energy Transport, Heat Transfer | | | **15. NUMBER OF PAGES** <br> 90 |
|---|---|---|---|
| | | | **16. PRICE CODE** |
| **17. SECURITY CLASSIFICATION OF REPORT** <br><br> Unclassified | **18. SECURITY CLASSIFICATION OF THIS PAGE** <br><br> Unclassified | **19. SECURITY CLASSIFICATION OF ABSTRACT** <br><br> Unclassified | **20. LIMITATION OF ABSTRACT** <br><br> UL |

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1996 | Dissertation |

**4. TITLE AND SUBTITLE**

Countering the Effects of Measurement Noise During the Identification of Dynamical Systems

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Odell R. Reynolds, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENG/96-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Duane Ruburtus
WL/FIGS
Wright-Patterson AFB OH 45433-7521

I found his work to be relevant, significant, and useful for the activities of the Electronic Combat Branch, RF Technologies Division, Avionics Directorate, Wright Laboratories. I will encourage all Wright Lab engineers and scientists to consider similar relationships with AFIT students and faculty. Theses relationships are valuable funds/manpower multipliers so necessary in today's environment of downsizing. Especially true when results are superior quality.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

Sensor noise is an unavoidable fact of life when it comes to measurements on physical systems, as is the case in feedback control. Therefore, it must be properly addressed during dynamic system identification. In this work, a novel approach is developed toward the treatment of measurement noise in dynamical systems. This approach hinges on proper stochastic modeling, and it can be adapted easily to many different scenarios, where it yields consistently good parameter estimates. The Generalized Minimum Variance algorithm developed and used in this work is based on the theory behind the minimum variance identification process, and the estimate produced is a fixed point of a mapping based on the minimum variance solution. Additionally, the algorithm yields an accurate prediction of the estimation error. This algorithm is applied to many different noise models associated with three basic identification problems. First, continuous-time systems are identified using frequency domain measurements. Next, a discrete-time plant is identified using discrete-time measurements. Finally, the physical parameters of a continuous-time plant are identified using sampled measurements of the continuous-time input and output. Validation of the estimates is performed correctly, and the results are compared with other, more common, identification algorithms. The GMV results are generally better.

**14. SUBJECT TERMS**

System Identification, Measurement Noise, Dynamical Systems, Generalized Minimum Variance

**15. NUMBER OF PAGES**

153

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| Unclassified | Unclassified | Unclassified | UL |

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | January 1997 | Dissertation |

**4. TITLE AND SUBTITLE**

Manual Tracking Flight Control with Amplitude and Rate Constrained Dynamic Actuators

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Russel B. Miller, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENG/96-15

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Duane Ruburtus
WL/FIGS
Wright-Patterson AFB OH 45433-7521

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This design data provides valuable insight into problems associated with rate limiting and the potential for avoiding the effects with due consideration in the initial steps. This research was an appropriate supplement to investigations into how to predict "pilot-in-the-loop" induced oscillations (PIO), how to specify design features that alleviate the potential for PIO, and how to react once a PIO has incurred.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

A new control methodology for manual flight control, viz, real-time tracking control, is developed. Amplitude and rate constrained dynamic actuators are considered. Optimal tracking control is made possible by the use of unique reference signal prediction strategies which extrapolate the reference signal over the optimization horizon. A receding horizon, linear-quadratic inner-loop controller is employed in conjunction with an outer-loop nonlinear element. The constraint effects mitigation strategy is to optimally track a modified reference signal which yields feasible actuator commands over the optimization horizon when the pilot demanded reference is too aggressive to be tracked by the inner-loop optimal control law. A discrete-time implementation yields conputationally inexpensive, closed-form solutions which are implementable in real-time and which afford the optimal tracking of an exgenous, unknown a priori reference signal. The developed control algorithm is applied to an open-loop unstable aircraft model, with attention being given to the trade-offs associated with the conflicting objectives of aggressive tracking and saturation avoidance. One-step ahead constraint mitigation is shown to provide substantial improvement in the constrained system response, while slightly more complicated constraint mitigation strategies yield stronger stability properties.

**14. SUBJECT TERMS**

Control systems, tracking control, actuator saturation, nonlinear control, amplitude saturation, rate saturation, actuator constraints, optimal control, receding horizon control, predictive control, flight control

**15. NUMBER OF PAGES**

146

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Two-Phase Damped-Expotential Model for Speech Synthesis

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

H. Allan Arb, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/96D-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Raymond Slyh
AL/CFBA
Wright-Patterson AFB OH 45433-7765

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

Funds have been too tight for us to contract for this work, and our personnel have been too heavily loaded for us to complete the work in-house. Thus, this work probably would not have been completed had AFIT not done it. I've been working closely with Dr. DeSimio and Capt Arb on this thesis topic, so they are already aware of my thoughts on the thesis work. However, it is precisely this close working relationship that has made AFIT a valuable resource for us.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

It is well known that there is room for improvement in the resultant quality of speech synthesizers in use today. This research focuses on the improvement of speech synthesis by analyzing various models for speech signals. An improvement in synthesis quality will benefit any system incorporating speech synthesis. Many synthesizers in use today use linear predictive coding (LPC) techniques and only use one set of vocal tract parameters per analysis frame of pitch period for pitch-synchronous synthesizers. This work is motivated by the two-phase analysis-synthesis model proposed by Krishnamurthy. In lieu of electroglottograph data for vocal tract model transition point determination, this work estimates this point directly from the speech signal. The work then evaluates the potential of the two-phase damped-exponential model for synthetic speech quality improvement. LPC and damped-exponential models are used for synthesis. Statistical analysis of data collected in a subjective listening test indicates a statistically significant improvement (at the 0.05 significance level) in quality using this two-phase damped-exponential model over single-phase LPC, single phase damped-exponential, and two-phase LPC for the speakers, sentences, and model orders used. This subjective test shows the potential for quality improvement of synthesized speech and supports the need for further research and testing.

**14. SUBJECT TERMS**

Speech, Speech Synthesis, Damped-Exponential, LPC, Analysis-Synthesis, ANOVA, Analysis of Variance, Human Subject Testing, Speech Modeling

**15. NUMBER OF PAGES**

105

**16. PRICE CODE**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | June 1996 | Doctoral Dissertation |

**4. TITLE AND SUBTITLE**

An Investigation of the Characteristics of Regenerative Heat Exchangers

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Timothy J. Murphy, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/96-5

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Larry D. Crawford
PL/VTP
Kirtland AFB NM 87117-5776

I have reviewed Capt Murphy's work and have concluded that the results of his work are equivalent to the technical effort expanded on a Phase I and Phase II Small Business and Innovative Research (SBIR) program. The total resources required for an equivalent SBIR program total approximately $500K. It is quite clear that Capt Murphy's work significantly contributes to understanding the characteristics of regnenerative heat exchangers used in spacecraft.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** (Maximum 200 words)

The objective of the current research was to investigate the effects of a reduction in screen thickness on the volume and compactness factor of stacked, wire-screen regenerators. An improved transient step-change method was devised which integrates experimental data with a numerical model of the flow to determine the heat transfer coefficient. The improvements to the method are: 1) the measured inlet temperature trace is used, 2) the heat transfer coefficient is based on the sponge effect delay in time, and 3) the important effect of the tube surround the matrix is included in the model. The data show that the heat transfer is the same for reduced thickness screens as it is for unrolled screens once the decrease in surface area caused by rolling the screens is taken into account. However, the friction increases, significantly for a 50% reduction in screen thickness. Consequently, the ratio of the Colburn factor to the friction factor, called the compactness factor, decreases as the thickness of the screen decreases The effectiveness of the regenerator was also adversely affected by rolling the screens.

**14. SUBJECT TERMS**

Regenerator, Heat Exchangers, Heat Transfer Coefficient, Regenerative Cooling, Porous Materials, Stirling Cycle

**15. NUMBER OF PAGES**

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | November 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

The preliminary Design of a Standardized Spacecraft Bus for Small Tactical Satellites (Volume 3)

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Gerald F. Ashby, Capt, USAF, et al

AFIT/GSE/GSO/ENY 96D-1

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Wright-Patterson AFB OH 45433-7765

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col James Rooney
PL/WSM
Kirtland AFB NM 87117-5776

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

Phillips Laboratory and Air Force Space Command were struggling with the idea of how to integrate small tactical satellites into an infrastructure which was already strained. After defining the parameters of the study and assigning a local point of contact, I essentially backed off from the whole issue and waited to see what a handful of AFIT students could do for practically no money and little if any support from the field. Over the past five years the Air Force has spent in excess of at least nine million dollars wrestling with the key ideas there were fundamental to the thesis proposed by the GSO team. The degree of sophistication in problem definition, systems analysis and synthesis as well as code development was simply outstanding. Such an effort, if I had placed on contract would easily have cost the government over $500K. The end product was simple, cost effective and extremely useful

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

Current satellite design philosophies concentrate on optimizing and tailoring a particular satellite bus to a specific payload or mission. Today's satellites take a long time to build, checkout, and launch. An alternate approach shifts the design paradigm to one that focuses on access to space, enabling tactical deployment on demand and the capability to put current payload technology into orbit, versus several years by today's standards, by which time the technology is already obsolete. This design study applied systems engineering methods to create a satellite bus architecture that can accommodate a range of remote sensing mission modules. System-level and subsystem-level tradeoffs provided standard components and satellite structures, and an iterative design approach provided candidate designs constructed with those components. A cost and reliability trade study provided initial estimates for satellite performance. Modeling and analysis based upon the sponsor's objectives converged the designs to an optimum solution. Major products of this study include not only a preliminary satellite design to meet the sponsor's needs, but also a software modeling and analysis tool for satellite design, integration, and test. Finally, the report provides an initial implementation scheme and concept for operations for the tactical support of this satellite system.

**14. SUBJECT TERMS**

| 15. NUMBER OF PAGES |
|---|
| 94 |

**16. PRICE CODE**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE<br>December 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

| 4. TITLE AND SUBTITLE | 5. FUNDING NUMBERS |
|---|---|
| Application of a Finite-Volume Time-Domain Maxwell Equation Solver to Three-Dimensional Objects | |

**6. AUTHOR(S)**

Frederick G. Harmon, Capt, USAF

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) | 8. PERFORMING ORGANIZATION REPORT NUMBER |
|---|---|
| Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | AFIT/GE/ENG/96D-06 |

| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER |
|---|---|
| Dr. J. S. Shang      Dr. Kueichien Hill<br>WL/FIM            WL/XPN<br>Wright-Patterson AFB OH 45433  Wright-Patterson AFB OH 45433 | |

**11. SUPPLEMENTARY NOTES**

Capt Harmon contributes more that one-person year of accomplishment to computational electromagnetics. The equivalent value, if procured through extramural means would exceed $80K. However, the intrinsic value of an excellent scientific achievement and mutual support among Air Force organizations is even greater. I greatly appreciate his devotion to his work and his ability to convert information of knowledge.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

ASSESSMENT
BY
ABOVE SPONSOR =

**13. ABSTRACT** (Maximum 200 words)

Concurrent engineering approaches for the disciplines of computational fluid (CFD) and electromagnetics (CEM) are necessary for the designing future high-performance, low-observable aircraft. A charcteristics-based finite-volume time-domain (FVTD) computational algorithm, developed for CFD and now applied to CEM, is implemented to analyze the radar cross section (RCS) of two three-dimensional objects, the ogive and cone-sphere. The FVTD formulation implements a Monotone Upstream-Centered Scheme for Conservation Laws (MUSCL) algorithm for the flux evaluation and a Runge-Kutta multi-stage scheme for the time integration. Developmental FVTD work for the thesis focused on algorithm development to analyze scattering and obtain RCS data for closed-surface perfect electric conductor (PEC) 3-D objects using either a Gaussian pulse or sinusoid incident wave. In addition, specification of the direction and polarization of the incident wave gives monostatic and bistatic RCS results. Convergence and threshold checks end the simulation run to ensure accurate computation of the RCS. Validation of the characteristic-based FVTD formulation and code for electromagnetic scattering problems is completed by comparing RCS results obtained from the FVTD code to Moment Method and empirical RCS data. The FVTD results for the ogive and con-sphere are within 3.0 dB of the MoM results and 3.1 dB of the empirical RCS results. Accurate FVTD computations of diffraction, traveling waves, and creeping waves require a surface grid point density of 15-30 cells $\lambda$.

| 14. SUBJECT TERMS | | | 15. NUMBER OF PAGES<br>168 |
|---|---|---|---|
| Electromagnetic Scattering, Radar Cross Section, RCS, Finite-Volume Time-Domain, FVTD, Computational Fluid Dynamics | | | 16. PRICE CODE |

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|---|---|---|
| | 25 June 1997 | Dissertation, April 1996-July 1997 |

**4. TITLE AND SUBTITLE**

Stepped Tip Gap Effects on a Transonic Axial-Flow Compressor Rotor

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Donald W. Thompson, Maj. USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/97-5

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Doug Rahe
WL/POTX
Wright-Patterson AFB OH 45433-7765

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

This is a great program, largely due to the efforts of Don Thompson and Paul King. This work has led to significant findings which are being further evaluated.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT (Maximum 200 words)**

The effects of stepped tip gaps and clearance levels on the performance, flowfield, and stall characteristics of a transonic axial-flow compressor rotor were experimentally and numerically determined. A theory and mechanism for relocation of blockage in the rotor tip region was developed. A two-stage compressor with no inlet guide vanes was tested in the Wright Laboratory's Compressor Research Facility located at Wright-Patterson AFB OH. The first-stage rotor was unswept and was tested for an optimum tip clearance with variations in stepped gaps machined into the casing neat the aft tip region of the rotor. Nine casing geometries were investigated consisting of three step profiles at each of three clearance levels. For small and intermediate clearances, stepped tip gaps were found to improve pressure ratio, efficiency, and flow range for most operating conditions. At 100% design rotor speed, stepped tip gaps produced a doubling of mass flow range with as much as a 2.0% increase in mass flow and a 1.5% improvement in efficiency. The flowfield characteristics associated with performance improvements were experimentally and numerically analyzed. Stepped tip gaps were found to have no significant effect on the stall characteristics of the rotor, the stability characteristics attributable to tip geometry were determined by the clearance over the forward portion of the rotor blade. This study provides guidelines for engineers to improve compressor performance for an existing design by applying an optimum casing profile.

**14. SUBJECT TERMS**

Axial-Flow Compressor, Transonic Rotor, Tip Clearance,, Stepped Tip Gap, Blockage, Aerodynamic Seal, Vortex Entrainment, Performance, Shock-Vortex Interaction, Stall

**15. NUMBER OF PAGES**

319

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1997 | Master's Thesis |

**4. TITLE AND SUBTITLE**

An Object-Oriented Simulation of the C-17 Wingtip Vortices in the Airdrop Environment

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Hans J. Petry, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOA/ENS/97M-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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C-17 SPO
Wright-Patterson AFB OH 45433-7105

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

Student/faculty did a great job! Presented useful ideas.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis effort focuses on the development of an object-oriented simulation of C-17 personnel airdrop operations and provides a tool for risk assessment of jumper and wingtip vortex interaction. Using the initial modeling efforts of the Wright Laboratory, this model expands those efforts to include random aircraft, wind and jumper movement within the simulation using MODSIM III as its language. Once the model was built, verified, and calibrated, it helped perform a preliminary analysis of jumper risk with varying element spacing and no crosswind. The results of the simulation provided 15 data points with which linear and logistic regression provided an estimation of the marginal rate of change of jumper/vortex encounter rate. Using the third order model shows that the encounter rate levels off around 24,000 feet spacing between element leaders at 12%, and stays as high as 11% at 32,000 feet before dropping to 0.4% at 34,000 feet. Further research and model improvements may bring the encounter rate down at the more distant spacing but that is left for post thesis analysis efforts.

**14. SUBJECT TERMS**

Vortex Modeling, Object-oriented Simulation, Airdrop Simulation, Paratrooper/Wake Vortex Encounter Modeling, MODSIM

**15. NUMBER OF PAGES**

177

**16. PRICE CODE**

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|---|---|---|---|

**4. TITLE AND SUBTITLE**

Three-Dimensional Sound Enhancement of a Radar Warning Receiver

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Roger M. Vincent, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG-97M-04

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Richard L. McKinley
AL/CFBA
Wright-Patterson AFB OH 45433-7901

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR = Dr. DeSimio did an excellent job in mentoring the student and facilitating the laboratory connection.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

This thesis investigates the integration of a three-dimensional (3-D) audio enhanced radar warning receiver (RWR) display. A 3-D enhanced RWR display provides a spatial auditory warning cue enabling the pilot to perceive the direction of the threat without the need to reference a visual display. The goals of this work are to determine the effect of the cockpit environment on auditory localization and demonstrate the potential of a 3-D audio enhanced RWR display. The investigation is conducted with rated military officers, replicated cockpit noise and operational RWR warning signals. The 3-D audio enhanced RWR display includes active noise reduction (ANR) earcups. A comparison of ANR earcups to conventional headphones shows no degradation of localization ability using ANR. An investigation on the effect of aircraft cockpit noise on localization shows no degradation of accuracy. A localization enhancement technique is demonstrated that yields a 2.3 improvement in localization accuracy as well as providing a cue that is perceptually easier to localize. The enhancement technique retains the attention demanding characteristics of auditory warning cues while improving the localization accuracy. In the first air-to-air application of this technology, an airborne demonstration confirms reliable auditory cueing; reduced pilot workload; and increase situational awareness.

**14. SUBJECT TERMS**

Three-dimensional Audio, Binaural Sound, Radar Warning Receiver, Helmet Mounted Display, Active Noise Reduction, Situational Awareness, Cockpit Noise

**15. NUMBER OF PAGES** 70

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1997 | Dissertation |

**4. TITLE AND SUBTITLE**

Advances in Time-Domain Electromagnetic Simulation Capabilities Through the Use of Overset Grids and Massively Parallel Computing

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Douglas C. Blake

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/DS/ENY/97-2

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Dr. Joseph Shang
WL/FIM
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**This dissertation actually developed a useful technology for aircraft evaluation.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

A new methodology is presented for conducting numerical simulations of electromagnetic scattering and wave-propagation phenomena. Technologies from several scientific disciplines, including computational fluid dynamics, computational electromagnetics, and parallel computing, are uniquely combined to form a simulation capability that is both versatile and practical. In the process of creating this capability, work is accomplished to conduct the first study designed to quantify the effects of domain decomposition on the performance of a class of explicit hyperbolic partial differential equation solvers; to develop a new method of partitioning computational domains comprised of overset grids; and to provide the first detailed assessment of the applicability of overset grids to the field of computational electromagnetics. Furthermore, the first Finite-Volume Time-Domain (FVTD) algorithm capable of utilizing overset grids on massively parallel computing platforms is developed and implemented. Results are presented for a number of scattering and wave-propagation simulations conducted using this algorithm, including two spheres in close proximity and a finned missile.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES |
|---|---|
| Parallel Computing, FVTD, CFM, Domain Decomposition, Overset Grids | 187 |
| | **16. PRICE CODE** |

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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|---|---|---|---|

**4. TITLE AND SUBTITLE**

System Comparison Procedures for Automatic Target Recognition Systems

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Anne E. Catlin, 2d Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION
REPORT NUMBER**

AFIT/GOR/ENS/97M-03

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Timothy D. Ross
WL/AAC
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING
AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT
BY
ABOVE SPONSOR =

**Anne's contribution to our organization is only partly reflected in her thesis. She provide valuable inputs as a consultant on a variety of topics throughout.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

Estimating the performance of an automatic target recognition (ATR) system in terms of probability of successful target identification involves extensive image collection and processing, which can be very time-consuming and expensive. We investigate the Wald sequential tests for the difference in two proportions as a sample size-reducing alternative to ranking and selection and the classical method of comparing binomial confidence intervals. The test is modified for the multiple pairwise comparison of four systems, and is applied to actual data to compare different configurations of the Moving and Stationary Target Acquisition and Recognition (MSTAR) System.

**14. SUBJECT TERMS**

Sequential Analysis, Multiple Comparisons, Probability, Binary Data Analysis, Methodology, Test and Evaluation, Automatic Recognition Systems

**15. NUMBER OF PAGES**
128

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION<br>OF REPORT<br>Unclassified | 18. SECURITY CLASSIFICATION<br>OF THIS PAGE<br>Unclassified | 19. SECURITY CLASSIFICATION<br>OF ABSTRACT<br>Unclassified | 20. LIMITATION OF<br>ABSTRACT<br>UL |
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| **REPORT DOCUMENTATION PAGE** | *Form Approved*<br>*OMB No. 0704-0188* |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>March 1997 | 3. REPORT TYPE AND DATES COVERED<br>Final |
|---|---|---|

| 4. TITLE AND SUBTITLE<br><br>C-17/Paratrooper Risk Assessment Analysis | 5. FUNDING NUMBERS |
|---|---|
| **6. AUTHOR(S)**<br><br>Jose C. Belano III, Capt, USAF | |

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | 8. PERFORMING ORGANIZATION REPORT NUMBER<br><br>AFIT/GOR/ENS/97M-01 |
|---|---|

| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br>Mark Kuntavanish<br>ASC/YC (MS) IPT<br>C-17 SPO<br>Wright-Patterson AFB OH 45433 | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER |
|---|---|

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =        **Student and advisor had clear understanding of concept/problem. Overall excellent job.**

| 12a. DISTRIBUTION AVAILABILITY STATEMENT<br><br>Approved for public release; distribution unlimited | 12b. |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

This thesis effort provides the C-17 test and evaluation community with the capability to assess paratrooper performance during C-17 drop formations. Object-oriented modeling is used to convert current static/deterministic parachute/payload system trajectory models of any degree of freedom into dynamic/stochastic models through the development of a class of parachute/payload system objects that are expandable to model not only personnel but equipment and different types of parachutes. The immediate impact of this thesis is assessing the risk of C-17 formations for brigade-size personnel airborne operations. However, the parachute/payload system objects can be expanded for use in a combat-modeling environment.

| 14. SUBJECT TERMS<br><br>Paratrooper Modeling; Parachute Trajectory Modeling, Object-Oriented Simulation, Airdrop Simulation, Airborne Simulation; Paratrooper/Wake Vortex Encounter Modeling | | 15. NUMBER OF PAGES<br>165 |
|---|---|---|
| | | 16. PRICE CODE |

| 17. SECURITY CLASSIFICATION OF REPORT<br>Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE<br>Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT<br>Unclassified | 20. LIMITATION OF ABSTRACT<br>UL |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1991 | Master's Thesis |

**4. TITLE AND SUBTITLE**
Preliminary Specification for Follow-on Multi-Role Fighter Aircraft Employed in the Air-to-Air Role.

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
Russel Towe, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Air Force Institute of Technology
2750 P Street
WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GST/ENS/91M-05

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
AFCSA/SAGF
Attn: Lt Col Keith Lange

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**
ASSESSMENT
BY
ABOVE SPONSOR =

The study approach developed by Maj Towe in his thesis is currently being used to evaluate proposals for next generation of air-to-air missiles. This evaluation formed the basis for our briefing to Gen Loh (HQ TAC) and Mr. Rice (SECAF).

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

SECRET

**13. ABSTRACT** *(Maximum 200 words)*

Not available

**14. SUBJECT TERMS**
Fighter aircraft, air-to-air combat

**15. NUMBER OF PAGES**

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1991 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Adaptive Estimation of Pseudorandom Binary Sequences

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Brian K. Anderson, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/91D-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

FASTC/TATC
Foregin Technology Center
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

This organization contracts our research topics-AFIT is an excellent resource that we here at FASTC need to utilize more often. The opportunity to work closely with the student produced a thesis that was optimized to our specific needs. Excellent results!

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Further dissemination only as directed by AFWL/AAWW-2,
Wright-Patterson AFB OH 45433 or higher DoD authority

**13. ABSTRACT** *(Maximum 200 words)*

This research investigated the feasibility of predicting future bits of a given linear pseudorandom binary sequence (PRBS) from past bits by adaptive techniques. An adaptive transversal filter (ATF) modified to operate in the Galois field of prime order 2, designated a GF2ATF, was used to model a linear feedback shift register (LFSR) which generated PRBSs. All tests were conducted in a noise-free environment on maximal-length sequences (MLSs) from 3,4,5,6, and 7 stage LFSRs. Eight weight update algorithms were developed and implemented and performance was established in terms of whether the GF2ATF converged and the time required to achieve convergence. Through the performance surface for the GF2ATF was empirically determined to be flat, one weight update algorithm was developed which resulted in a mean convergence time (MCT) of less than one third of a MLS period. The GF2ATF occasionally failed to converge for some weight update algorithms because the adaptation entered an endless loop of improper adaptive weight settings.

**14. SUBJECT TERMS**

Adaptive Estimation, Prediction, Pseudorandom, Pseudonoise, Binary Sequences, Spread Spectrum

**15. NUMBER OF PAGES**

237

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1992 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Optimization of Stochastic Response Surfaces Subject to Constraints with Linear Programming

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert G. Harvey, 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/92M-14

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Parnell
AF/SAA/SAY
The Pentagon
Washington DC

Extracted from a letter dated 18 Mar 93, from Maj Gen Phillip Ford AMC/XP to Lt Gen Kelley, AU/CC.: A recent graduate from AFIT, Capt Harvey, has introduced techniques and approaches he learned while a student in the Operational Science Department that are revolutionizing the way we do analysis and present information. This approach which we call "Capability Based Methodology," has captured the attention of the. Air Mobility Command and holds tremendous potential for future analysis & decision making. The Individual most responsible for mentoring and encouraging Capt Harvey through the thesis research was one of your AFIT faculty members, Lt Col Ken Bauer. The Operational Science Department has once again proven that it provides an invaluable service to the operations of the Air Force.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

This research investigated an alternative to the traditional approaches of optimizing a stochastic response surface subject to constraints. This research investigated the bias in the expected value of the solution. A three step process is presented to evaluate stochastic response surfaces subject to constraints. Step 1 uses a traditional approach to estimate the response surface and a covariance matrix through regression. Step 2 samples the objective function of the linear program (i.e. the response surface) and identifies the extreme points visited. Step 3 presents a method to estimate the optimal extreme point and present that information to a decision maker.

**14. SUBJECT TERMS**

Optimization, Response Surface Methodology, Simulation, Regression Analysis, Linear Programming

**15. NUMBER OF PAGES**

115

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1991 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**

SWATTER (Space-based Weapons Against Tactical Terrestrial Resources): A Design for Integrating Space into a Theater Level Wargame

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Duane R. Cozadd, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GSO/ENS/91D-6

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. K. Lavoie
AU/AFWC
Maxwell AFB AL

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This thesis explored the use of space-based weapons in a conventional warfare simulation. It answered our request for a way to mathematically model and integrate lethal space-based systems in a conventional combat situation. The investigation was accomplished to give us a better understanding of the complexitiesand limitations of space-based weapon systems and orbital mechanics. Maj Cozadd's work in this area was exceptional and appreciated.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis provides the foundation to expand the newly developed theater level computerized wargame, SABER, at the Air Force Wargaming Center, Maxwell AFB AL to include space conflict at the theater level of simulation. Building upon recently completed SABER, this thesis effort expands the conceptual framework of the model by integrating the dynamics of space warfare into the current theater level model. This expansion forms a new game called SWATTER. This thesis adds the space units required to integrate the land and air battles with the possible interactions from space. This thesis expands the stochastic attrition processes to include interactions between space forces, ground forces, and air forces with the use of unclassified engineering models. The use of these models results in credible interactions throughout SWATTER. The main components of SWATTER include satellite constellation determination, mapboard representation of the satellite constellation, detection and targeting processes, intelligence, command and control processes, laser weapon interactions, and stochastic attrition. The goal is to provide sufficient documentation on the necessary algorithms and related equations for programmers to build a computer simulation with a reasonable run time and credible output.

**14. SUBJECT TERMS**

Wargaming, War Games, Space, Warfare, Satellite Constellations, Lasers

**15. NUMBER OF PAGES**
144

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>March 1993 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

The Integration of Tanker Aircraft into Aslar

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

John S. Stieven, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GST/ENS/93M-12

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Col Patrick F. Nolte
ATSC/CC
Scott AFB IL 62225-5219

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

I was very interested in how Maj Stieven achieved his computer simulation and felt that it would be a very useful tool to study separation minima and the various parameters that can affect it. This simulation could prove extremely useful to MAJCOMS and bases that are designing ASLAR approaches to see how their particular approach will fork and/or find ways to improve the procedures. In this respect I feel that his work could save the AF resources.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this study was to analyze the proposed addition of heavy KC-135 tanker aircraft to the United States Air Force Aircraft Surge Launch and Recovery (ASLAR) instrument approach system. The Air Force Communications Command, which oversees ASLAR operations, will use these results to determine if KC-135 aircraft should be permitted to fly ASLAR approaches. A SIMSCRIPT II.5 animated simulation model was developed to simulate the Runway 26 approach at Seymour Johnson AFB under a variety of wind conditions. This model was expanded to shoe the feasibility of KC-135s flying ASLAR approaches and to determine proper controller procedures to prevent the minimum enroute separation between aircraft from being violated. The study noted a concern with reduced separation between a KC-135 and a trailing fighter due to wake turbulence and recommended a cautious, incremental approach to be applied to reducing the enroute distance.

**14. SUBJECT TERMS**

ASLAR, Aircraft, Simulation

**15. NUMBER OF PAGES**
104

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Generalized Simulation Model for a Typical Medical Treatment Facility Obstetrical Unit

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Annette M. Stephens

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/93M-20

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj Tim Ward
HQ USAF/SGSFW
Bolling AFB DC 20332-6188

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

Capt Stephens had done a remarkable job in accurately describing patient and staff flow within the obstetrical unit at Wright-Patterson AFB Medical Center. The fundamental obstetrical department operations identified in this simulation model have future application for both facility planning and nurse and technical support personnel staffing throughout the Air Force and other Military Treatments Facility (MTF) hospitals. The simulation model developed by Capt Stephens permits detailed analysis of resource implications associated with the provision of obstetrical services, better allocation of scare resources within MTF hospitals, and potentially reduced CHAMPUS expenditures. Our office is currently working to further the research and analysis begun by Capt Stephens.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this research was to develop a decision support tool for users at Air Force Medical Treatment Facility obstetrical (OB) units. The immediate needs of the generalized simulation model contained in this research provide obstetrical wards with the capability to identify unit effectiveness as well as the ability to predict future performance. As a result of this model, decision-makers will now have access to information on system performance as well as insight into the effects of changing conditions. This model was formulated with the flexibility to be adapted to OB wards at regional and local hospitals throughout the Air Force. The generalized approach provides staff the opportunity to explore alternative policy options without detrimental effects on system performance. Options associated with patient arrival, departure, and service conditions can now be fully explored. Possible nurse scheduling options are also afforded through model output.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES |
|---|---|
| Simulation, Obstetrics, Obstetrical Unit, Systems Analysis | 152 |
| | 16. PRICE CODE |

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Integration and Enhancement of the Saber Wargame

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Karl S. Mathias, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCS/ENG/93D-15

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Barry G. Litherland
AU CADRE/WG
Maxwell AFB AL 36112

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

This thesis was comprehensive and thoroughly researched. Further, it represents a major milestone for us as the capstone of our SABER evaluation and implementation initiative. The lessons learned from the SABER papers have been used to improve the Air Force Combat Exercise System (ACES) models and software. ACES has several mature, fielded wargames operationally supporting a number of domestic and foreign senior service schools. A t the same time, work continues toward building workable joint models, expanding model capabilities, improving user interfaces, and migrating ACES into the open system arena. Downsizing the AF directly impacts our mission in at least two areas: resources and customers. As a meaningful alternative to field exercises, we are faced with a rapidly growing list of potential customers with various needs, expectations, and capabilities.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The Saber wargame is a theater-level air/land battle wargame written in Ada that is being developed for the Air Force Wargaming Center at Maxwell AFB AL. This thesis documents how the user interface and simulation engine were integrated. Integration was accomplished by developing a potable object-oriented database system (OODBMS) interface. The interface was implemented in Ada and tied to an OODBMS also written in Ada. Using the interface, both subsystems were able to work from a consistent database and exchange information. The user interface was enhanced by converting it from the Software Technology for Adaptable Reliable Systems Ada/X Window System bindings to a newer commercial set. Generic components were constructed to allow the rapid development of Motif input forms written in Ada.

**14. SUBJECT TERMS**

Wargame Simulation, Software Engineering, Ada, Databases, Object-Oriented Databases, Graphical User Interface Bindings, X Window System

**15. NUMBER OF PAGES**

159

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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|---|---|---|

| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | | |

**4. TITLE AND SUBTITLE**

Identification of Significant Outliers in Time Series Data

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Keri L. Robinson, Capt., USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GNE/ENP/93M-7

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Ronald R. Culp, Jr.
AFTAC/TNR
Patrick AFB FL 32925

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

The plan is for the algorithm to be coded next year during a major upgrade to our software + database resources. The code will then be one of at least three different data-screening tools employed by our nuclear evaluators.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis examines the feasibility of using least median of squares (LMS) procedure applied to a reweighted least squares (RLS) autoregression model to identify significant outliers in time series data. The time series were analyzed for data points that were outliers. In order to perform detailed analysis on an outlier, the analyst must be able to determine that an outlier data point is significantly different from normally distributed data. This thesis examines a new method for identifying these outliers. Data from the field were characterized and fit with time series models an autoregressive reweighted least squares routine (ARRLS) derived from the LMS methodology. Various orders of autoregression were applied to the AARLS method to determine an appropriate order for the model; resulting fit coefficients were tests for significance. Regression results from the data taken at five sites are presented. By using an autoregressive order of one (AR(1)) applied to the ARRLS, this method significantly improved outlier detection in the time series data over the recursive removal without regression (RRR) method currently in use. In addition to identifying the outliers found by RRR, the AR(1)-RLS method routinely identified four items as many outliers as AFTAC's RRR method. The AR(1)-RLS method is recommended as a complimentary procedure to the RRR method currently used in identifying significant outliers. After sufficient operational experience is gained, AR(1)-RLS may supplant current schemes. Recommendations for improvements to the AR(1)-RLS method are offered.

**14. SUBJECT TERMS**

Outlier, Least Squares, Autoregression, Least Median Squared Residuals

**15. NUMBER OF PAGES**

146

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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|---|---|---|
| | September 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Evaluation of the Total Petroleum Hydrocarbon Standard for Cleanup of Petroleum Contaminated Sites

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Rick Allen Blaisdell
Mark Everett Smallwood

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GEE/ENV/9SS-1

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Ross Miller
AFCEE/EST
Brooks AFB TX 78235

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

This thesis is being sent out, together with a supporting document, to AL/AF RPM's to support the AFCEE Risk Based approached to hydrocarbon cleanup. This work will make a significant impact.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This study evaluated TPH (total petroleum hydrocarbon) cleanup standard for petroleum contaminated soils (PCS). A survey of 13 state regulators was performed to characterize current standards and regulatory viewpoints on the use of TPH versus a BTEX cleanup standard. The regulatory community considers the BTEX constituents the greatest threat to groundwater; yet expressed concern that the use of a compound specific standard, without an accompanying analysis of BTEX to TPH in soil over time. Based on JP-4 contaminated site oil data, this study demonstrated that the ratio of BTEX to TPH declines with time. The results indicate that the constant ratio of BTEX to TPH assumed by the California LUFT manual and Stokman and Dime's research is not valid for soils contaminated with JP-4. Lastly, this research identified the cost savings potential that would result if a BTEX based standard, versus a TPH standard, were required at all Air Force sites. The research shows that only 13% of sites which would require cleanup under a TPH standard would require cleanup under a BTEX based standard.

**14. SUBJECT TERMS**

Soil Cleanup Standards, Petroleum Hydrocarbons, Total Petroleum Hydrocarbons, TPH, Bezene, Toluene, Ethylbenzene, Ethyl-bezene, Xylene, BTEX, Petroleum Contamination, JP-4

**15. NUMBER OF PAGES**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
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| | September 1992 | Master's Thesis |

**4. TITLE AND SUBTITLE**

THE APPLICATION OF FUNCTION POINTS TO PREDICT
SOURCE LINES OF CODE FOR SOFTWARE DEVELOPMENT

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Garland S. Henderson, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology, WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

SSC/XPEP, Building 888
Maxwell AFB - Gunter Annex, AL 36114

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

Good stuff! Actually adds credence to some things SSC has been saying for a long time but without research to back up.

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release, distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

This research investigated the results of using function point analysis-based estimates to predict source lines of code (SLOC) for software development projects. The majority of software cost and effort estimating parametric tools are categorized as SLOC-based, meaning SLOC is the primary input. Early in a program, an accurate estimate of SLOC is difficult to project. Function points, another parametric software estimating tool, bases software cost and effort estimates on the functionality of a system. This functionality is described by documents available early in a program. Using a modeling methodology, the research focuses on function point's ability to accurately estimate SLOC in the military and commercial environments. Although a significant relationship exists in both environments, none of the models provided a goodness of fit, predictive capability, and significance level to make them acceptable models, especially noted in the variability of the estimates of SLOC. The need to use models developed in similar environments was made clear. The concept of function point to SLOC conversion tables was assessed and was justified. However, the conversion tables to be used should be based on similar programs developed in similar environments. Universally applicable function point to SLOC conversion tables were not supported by this research.

**14. SUBJECT TERMS**

Statistical Analysis, Software Engineering, Cost Estimates,
Cost Models, Models, Function Points, Software Estimation

**15. NUMBER OF PAGES**

201

**16. PRICE CODE**

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|---|---|---|
| | September 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Comparison of the Disaster™ Scheduling Software With a Simultaneous Scheduling Algorithm for Minimizing Maximum Tardiness in Job Shops

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Barak J. Carlson, Capt, USAF
Christopher A. Lettiere, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GSM/LAS/93S-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

HQ AFMC/LG-PP
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**
ASSESSMENT
BY
ABOVE SPONSOR =

Results of this research can play key role in helping managers of production processes develop schedules that are both robust and efficient. Looking forward to continuation of this research stream.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

The Theory of Constraints (TOC) is the foundation for a computerized scheduling system called DISASTER™. Although this system has proven successful in many manufacturing settings, it has potential limitations due to the sequential heuristic process by which it schedules constraints. The objective of this thesis was to determine the extent to which these limitations impact the due date performance of schedules created by DISASTER™. This objective was addressed by developing an algorithm to simultaneously schedule multiple constraints in a job shop environment and provide the optimal schedule for minimized tardiness. This algorithm was used to obtain solutions for a matrix of job shop problems, which were compared with solutions obtained by using DISASTER™. This comparison showed that DISASTER™ is capable of producing nearly optimal solutions for minimized maximum tardiness, but that this capability is highly dependent on proper constraint sequencing.

**14. SUBJECT TERMS**

Theory of Constraints, Job Shop Scheduling, Production Scheduling, Computer Programs, Tardiness, Branch and Bound

**15. NUMBER OF PAGES**
105

**16. PRICE CODE**

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**4. TITLE AND SUBTITLE**

DEVELOPMENT OF THE AIR FORCE CONTINGENCY CONTRACTING
COURSE FRAMEWORK

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

David A. Bethany, Captain, USAF
Michael A. Miller, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

SAF/AQCO ATTN: Col James Barager
The Pentagon
Washington, DC 20330

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**Good product. Hopefully will help add impetus to establishment of contingency contracting formal course.**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

The objective of this research was to develop a framework for a standardized Air Force Contingency Contracting course. This task was undertaken due to the occurrence of a common recommendation calling for specialized training in Contingency Contracting. The recommendation was found in several AFIT theses, as well as, various after action reports generated due to the experience gained during Operation Desert Shield/ Storm and Hurricane Andrew.

This thesis answered the basic questions of need, content, and structure for a future course in Contingency Contracting. Using an exploratory research design, the research team was able to conduct an extensive analysis on completed formalized research in the area of Contingency Contracting.

The outcome of the research is a four-phased, block of instruction with recommended training topics and first hand accounts of contingency contracting. The blocks of instruction can be used alone or as a segment in current DOD Contracting Courses.

**14. SUBJECT TERMS**

Contingency, Contracting, Training, Course Framework, Desert Storm

**15. NUMBER OF PAGES**
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| | September 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Repair Process Improvement at the Ogden Air Logistics Center, Landing Gear Division: A Case Study in the Application of the Theory of Constraints

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Mr. David A. Maddox
Susan L. Martz, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

HQ AFMC/LGPP
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = Research provides much needed perspective on a current process improvement methodology.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

This study explored the nature and extent of success that resulted from the implementation of the Theory of Constraints (TOC) in a depot repair environment. The actions taken to implement TOC were determined. Performance measures which defined success were identified and data were collected and summarized to demonstrate performance before and after implementation of TOC concepts. Improvements in flowdays and work-in-process (WIP) were determined to be attributable to the TOC effort. In addition, the unique characteristics of probabilistic repair and supply system variability were noted as those characteristics that posed the greatest challenges to implementing TOC in a remanufacturing environment. Despite these challenges, analysis revealed that the Landing Gear Division at Ogden Air Logistics Center (ALC) successfully implemented TOC concepts and improved performance within the wheel repair process in terms of the performance measures defined.

**14. SUBJECT TERMS**

Theory of Constraints, Process Improvement, Quality Improvement Production Management, Landing Gear Repair

**15. NUMBER OF PAGES**

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| | December 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

The Enhanced Performance of an Integrated Navigation System in a Highly Dynamic Environment

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Brian J. Bohenek

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

This research was extremely valuable. Additionally, doing this research taught Brian what he needed to know to become immediately effective in the office. Thus, research and relationship between AFIT and CIGTF is extremely valuable to us.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** (Maximum 200 words)

For the US Air Force to maintain an accurate and reliable Navigation Reference System (NRS) with Carrier-Phase Global Positioning System (CPGPS) measurements, it must develop an accurate and robust NRS in the face of cycle slips caused by highly dynamic maneuvers. This research investigates the implementation of a double differencing between receivers/satellites scheme to improve the accuracy of current NRS models. The removal of the "perfect Doppler velocity aiding measurements" (a very poor assumption of past research) was completed with stable and accurate results. The double differencing implemented showed improvement in the accuracy of the NRS. An investigation of two Failure Detection, Isolation, and Recovery (FDIR) algorithms for large cycle slip failures is conducted. The two FDIR techniques are the Chi-Square test and a Multiple Model Adaptive Estimator (MMAE). The FDIR results show that a Chi-Square tests as a stand-alone algorithm can work accurately for detection and isolation of failures with an accurate and reliable recovery algorithm. The MMAE algorithm as conjectured seems to be the best FDIR techniques to handle single and multiple cycle slips accurately and reliably.

**14. SUBJECT TERMS**

Carrier-Phase GPS, Cycle Slip, Global Positioning System, GPS, Extended Kalman Filter, Navigation Reference System, MSOFE

**15. NUMBER OF PAGES**

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE September 1994 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |
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**4. TITLE AND SUBTITLE**

LOGISTICS CONTROL FACILITY: A NORMATIVE MODEL FOR TOTAL ASSET VISIBILITY IN THE AIR FORCE LOGISTICS SYSTEM

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Eric C. Lorraine, Captain USAF
Michael E. Michno, Captain USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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WPAFB OH 45433-6583

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**Widely distributed through informal channels. Is influencing policy and practices and research in total asset visibility and lean logistics areas.**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

Computer simulation was used to evaluate the impact of a Logistics Control Facility (LCF) with a Total Asset Visibility (TAV) system on the AF logistics system's ability to support a weapon system. For this study, the B-1B was chosen as the weapon system of interest. Two performance measures, expected fully mission capable rates and expected pipeline quantities, were used to evaluate the simulation results. Two-sample t tests were used to compare the current logistics configuration of the B-1B with that same configuration, but with an LCF controlling the movement of assets. The expected FMC rate performance measure showed significant results while the expected pipeline quantity performance measure did not. After determining that the LCF with a TAV system did have an impact on the ability of the AF logistics system to support a weapon system, fourteen different support configurations were evaluated. Variables included mode of transportation, use of buffer stocks, and use of intermediate repair facilities. Analysis of the results was accomplished using a randomized block ANOVA and Least Significant Difference comparison of means. For expected fully mission capable rates, mode of transportation was the most significant factor. For expected pipeline quantities, the use of intermediate repair facilities was the most significant factor.

**14. SUBJECT TERMS**

Logistics, Dyna-METRIC, Computer Simulation, B-1B, Information Systems, Two-level Maintenance

**15. NUMBER OF PAGES** 175

**16. PRICE CODE**

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| 4. TITLE AND SUBTITLE <br> AN ANALYSIS OF THE EFFECTS OF LEAN LOGISTICS ON THE CURRENT AIR FORCE REPARABLE PIPELINE: A SIMULATION STUDY | 5. FUNDING NUMBERS |
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**6. AUTHOR(S)**
Tracey L. Hill, Capt., USAF
William N. Walker, Capt., USAF

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <br> Air Force Institute of Technology <br> WPAFB, OH 45433-6583 | 8. PERFORMING ORGANIZATION REPORT NUMBER <br> AFIT/GLM/LAL/94S-22 |
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**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**Impressed by quality and enthusiasm of one of the authors and hired her.**

| 12a. DISTRIBUTION/AVAILABILITY STATEMENT <br> Approved for public release; Distribution Unlimited. | 12b. DISTRIBUTION CODE |
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**13. ABSTRACT (Maximum 200 words)**

This research investigates the effect of Lean Logistics proposals on the current Air Force reparables pipeline. Lean Logistics proposes reducing reparable asset levels at operating bases, reducing transportation time between bases and depots, and reducing depot repair times. Computer simulation is used as a tool to perform a 3X3X3 full factorial experiment to determine the effects of the Lean Logistics proposals on fully mission capable aircraft and transportation cost. Results indicate that Lean Logistics outperforms the current reparables pipeline in term of fully mission capable aircraft. A cost benefit analysis is performed to determine the trade offs between transportation costs and asset outlays.

| 14. SUBJECT TERMS <br> Logistics management, Pipeline, Inventory, Transportation, Repair | 15. NUMBER OF PAGES <br> 218 |
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| 4. TITLE AND SUBTITLE<br><br>The Certification Program, Training, and Competencies - An Examination of the Air Force Contracting Work Force's Response to the Sufficiency of Professional Training | 5. FUNDING NUMBERS |
|---|---|
| **6. AUTHOR(S)**<br><br>Patty L. Jones, GS-12<br>Suzanne O. Staugler, 1Lt, USAF | |

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | 8. PERFORMING ORGANIZATION<br>REPORT NUMBER<br><br>AFIT/GCM/LAR/94S-3 |
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**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**Outbriefed Deputy Assistant Secretary for Contracting - excellent presentation and results can be used to build on.**

| 12a. DISTRIBUTION AVAILABILITY STATEMENT<br><br>Approved for public release; distribution unlimited | 12b. DISTRIBUTION CODE |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

This study determined to what extent AF contracting personnel training needs are sufficiently being satisfied by the current DoD training as outlined in DoD 5000.52M. A convenience sample was employed. 499 surveys were administered to Professional Continuing Education students for various level I through III courses. 320 surveys were used for the data base, achieving a 64.1% response rate. The results of this study show that the training requirements were viewed as sufficiently ensuring that the AF has a mission ready professional work force by slightly more than half of the respondents. However, the training component was ranked as the most important component of the career development program by the fewest number of respondents. Respondents indicated the need for improvement in the areas of specificity and timeliness of training. The training courses were perceived as overall adequate in meeting respondent needs. Key competencies for review were identified based on upward trend and correlational analysis.

| 14. SUBJECT TERMS<br><br>Contracting, Procurement, Acquisition, Training | 15. NUMBER OF PAGES<br>171 |
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**4. TITLE AND SUBTITLE**

Defective Pricing: An Analysis of Factors Affecting Sustention Rates and Disposition Times

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Tracey D. Kop, Capt, USAF
Dawn C. Sutton

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

AFMCLC/JAN
Wright-Patterson AFB OH 45433-7135

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**Thesis served excellent cost-benefit relationship purpose.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Defective pricing occurs when contractors fail to disclose current, accurate, and complete cost or pricing data in their proposals. Failure to submit valid data entitles the government to a refund in the amount of overpayment. With the current backlog of overage defective pricing cases and the continuing decline in sustention rates, a better understanding of the factors affecting timely and successful recoupment of defective pricing funds is needed. This research identifies factors which significantly affect sustention rates and disposition times and presents models to predict both rates and times. Factors were identified through a literature review and interviews with defective pricing experts. Analysis of variance (ANOVA) was used to determine the statistical significance of the identified factors. ANOVA results indicated that the following factors have the strongest impact on both rates and times: alleged defect amount, number of issues, legal complexity, method of disposition, identity of prime contractor, product center, and interest. The models developed explain 73.4% and 48.5% of the variation in sustention rates and disposition times, respectively. Recommendations for improving sustention rates and disposition times based on the research findings are also included.

**14. SUBJECT TERMS**

Defective Pricing, Truth in Negotiations Act, TINA, Contract Pricing, Government Procurement, Contracts

**15. NUMBER OF PAGES**
130

**16. PRICE CODE**

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| GENCY USE ONLY (Leave blank) | 2. REPORT DATE September 1996 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |
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| TLE AND SUBTITLE DES A RUBBER BASELINE GUARANTEE OVERRUNS?" TUDY OF COST PERFORMANCE AND CONTRACT CHANGES IN UOR DEFENSE ACQUISITION PROGRAMS | 5. FUNDING NUMBERS |
|---|---|

UTHOR(S)

es A. Gordon, Captain, USAF

| ERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S) ir Force Institute of Technology 750 P Street PAFB OH 45433-7765 | 8. PERFORMING ORGANIZATION REPORT NUMBER AFIT/GSM/LAS/96S-5 |
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| PONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Wayne Abba artment of Defense, Office of the Under Secretary of Defense (Acquisition & nnology), Acquisition Program Integration/Performance Management ress: OUSD(A&T)API/PM, RM 3E1025 DIR ACQUISITION PROGRAM INTEGRATION 3020 DEFENSE PENTAGON WASHINGTON DC 20301-3020 hone: (703) 695-5166 ax: (703) 693-7043 mail: abbawf@acq.osd.mil | 10. SPONSORING / MONITORING AGENCY REPORT NUMBER |
|---|---|

**Part of ongoing series that is making major contribution to state of art of project/contract management. AFIT providing real service through this research. Many intriguing insights & avenues for further research.**

UPPLEMENTARY NOTES

ASSESSMENT
BY
ABOVE SPONSOR =

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ABSTRACT (Maximum 200 Words)

This thesis explores the assumption that cost overruns are related to contract changes. A common assertion in defense ature says that contracts which are relatively stable suffer smaller overruns than those which are highly volatile. The stability or ility of contracts is characterized by their change history. A contract which is modified frequently or by large amounts is more able, or volatile, than one which is not changed either as often or by lesser amounts. This study attempts to find evidence orting this common assertion by examining the relationship between cost growth and baseline stability on over 400 Major nse Acquisition Program contracts over the last 26 years. The results are intriguing because, counter-intuitively, no significant ence is found. Possible explanations and implications of this discovery are provided.

| UBJECT TERMS Analysis, Program Management, Contract Management, Defense Acquisition, artment of Defense, Baseline Management | 15. NUMBER OF PAGES 110 |
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| | September 1994 | Master's Thesis |

| 4. TITLE AND SUBTITLE | 5. FUNDING NUMBERS |
|---|---|
| A PROTOTYPE KNOWLEDGE-BASED EXPERT SYSTEM FOR MISSILE MAINTENANCE FAULT ANALYSIS | |

**6. AUTHOR(S)**

Larry D. Martin, Captain, USAF
Scott B. Milton, Major, USAF

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) | 8. PERFORMING ORGANIZATION REPORT NUMBER |
|---|---|
| Air Force Institute of Technology WPAFB OH 45433-6583 | AFIT/GLM/LAR/94S-28 |

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| 90 LSS/LGLO 5305 Randall Ave F.E. Warren AFB WY 82005-2274 | |

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =
**Added greatly to current study/prototype program for decision analysis.**

| 12a. DISTRIBUTION / AVAILABILITY STATEMENT | 12b. DISTRIBUTION CODE |
|---|---|
| Distribution limited to U.S. government agencies and their contractors; administrative/operational use, July 1994. Other requests for this document must be referred to OGDEN ALC/PKDT, Hill AFB, UT 84056 | |

**13. ABSTRACT (Maximum 200 words)**

The purpose of this study was to determine if a knowledge-based expert system could be developed for intercontinental ballistic missile (ICBM) maintenance. This study focused on the missile maintenance fault analysis conducted at the operational level. An extensive literature review revealed that a knowledge-based expert system offered capabilities that are compatible with missile maintenance fault analysis. A prototype knowledge-based expert system was built using principles and techniques acquired during the literature review. Five research questions were developed to determine the overall effectiveness of the expert system. Thirty scenarios were tested using both the prototype knowledge-based expert system and the manual method currently in place. Based on these five research questions, several conclusions were reached. First, commercially available software shells can easily be used to develop an appropriate expert system. Second, the necessary missile maintenance knowledge can easily be stored and accessed. Third, priorities and various site modifications can easily be incorporated into an expert system. Finally, the prototype knowledge-based expert system was just as accurate as, yet faster than, the non-computerized system used today.

| 14. SUBJECT TERMS | | | 15. NUMBER OF PAGES |
|---|---|---|---|
| Artificial Intelligence, Knowledge Based Systems, Expert Systems, Maintenance, Troubleshooting | | | 240 |
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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE<br>September 1995 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**
ORDER & SHIP TIMES OF COMMUNICATION-ELECTRONIC
COMPONENTS UNDER LEAN LOGISTICS AND CONVENTIONAL
AIR FORCE REPARABLE PIPELINE: A COMPARATIVE STUDY

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Clifford G. Altizer, First Lieutenant, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology,
WPAFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GTM/LAL/95S-1

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

HQ USAF/LGMM
Washington DC 20330

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**
ASSESSMENT
BY
ABOVE SPONSOR =

Research critical to Air Force Lean
Logistics program. Interested in all
research related to lean logistics and to
business logistics processes.

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

Lean logistics (LL) is a new logistics system that applies state-of-the-art business practices utilized in private industry to Air Force logistics processes. Several LL demonstrations have been initiated to develop the best way to implement these new practices in the operational arena. This study focused on the Command, Control, Communications, and Computers (C4) lean logistics demonstration. The reparables in this demonstration differ from aircraft reparables in that they are highly reliable and high-value items. This research determines that the use of LL principles results in shorter order and ship times for the customer. As a follow-on to this finding, the study presents a methodology for comparing the cost of carrying inventory under LL and the traditional pipeline and demonstrates how LL principles result in considerably lower carrying costs.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES |
|---|---|
| Centralization, Communications-Electronics, Lean Logistics, Logistics Pipeline, Maintenance Management, Reengineering Logistics, Two-Level Maintenance. | 69 |
| | **16. PRICE CODE** |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>September 1995 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**

A Performance Analysis of the Air Force "Ware Time" Lean Optics Pipeline

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Craig S. Gaddis, Capt, USAF
David A. Haase, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

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HQ USAF/LGM-2
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Washington DC 20330-1036

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = **Great job. Fits right in with future of Air Force logistics.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Lean Logistics is an innovative proposal designed to reduce the costs associated with reparable inventory management. The purpose of this thesis is to determine whether a wartime lean logistics pipeline can maintain acceptable aircraft availability rates in response to induced variations of order and ship time (OST) and flying hours for deployed forces. The Dyna-METRIC Version 6.4 simulation program was used to evaluate nine different factor-level combinations. The factors, OST and flying hours were varied a three different levels, low, medium, and high. Analysis of the results was accomplished using a two-factor ANOVA. The authors discovered that while increasing OST greatly degraded available aircraft, flying hours did not significantly affect aircraft availability.

**14. SUBJECT TERMS**

Logistics, logistics management, logistics planning, logistics support, spare parts

**15. NUMBER OF PAGES**

82

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| | March 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Applications of Statistical Process Control In Monitoring Aircrew Bombing – Proficiency

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Kirk G. Horton, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB·OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAO/ENS/95M-03

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj Marshall C. Miller
AFSEO/SCPZ
Eglin AFB FL 32542-6865

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

This was a good start. Actual application of SPC/SQL in a real Fighter Bomber squadron is the next step. However someone knowledgeable in these techniques is required. A first step would be basic SPC/SQL/Control Chart training for a weapons tactics shop, followed by full-scale integration into the weapons training process.

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The current tools used by squadron supervisors to monitor the bombing performance of aircrews flying F-111E aircraft are monthly reports that have little predictive capability. No real-time methodology exists for monitoring and predicting aircrew bombing performance and preventing problems that might cause an individual to become unqualified. It has been suggested that Statistical Process Control (SPC) can be applied to the bombing process to develop tools for managing the process, correcting problems, and improve the bombing performance of a squadron. This study investigates the application of SPC to the bombing process. It examines data taken from an F-111E Fighter Wing during a six-month training period. The goal is to develop a control charting scheme that is both useful to squadron supervisors as well as simple to apply by squadron weapons officers. The results indicate that SPC methodologies can have significant impact on the bombing process. Control charts generated from the data can give insights in the bombing performance of individuals, as well as in the bombing performance of individuals, as well as in the bombing performance of their squadron as a whole.

**14. SUBJECT TERMS**

Fighter Aircraft, Bomber Aircraft, Weapons Delivery, Bombing, Statistical Process Control, Control Charts

**15. NUMBER OF PAGES**

74

**16. PRICE CODE**

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| | September 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Evaluation of the Management of the Department of Defense's Wholesale Ammunition Stockpile

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

David J. Rega, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GLM/LAR/95S-15

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HQ AFMC/DRW
Wright-Patterson AFB OH 45433

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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First unbiased customer survey of single manager organization. Product being used by single manager to make policy decisions

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

This research solicited expert opinions regarding how well the Single Manager for Conventional Ammunition (SMCA) manages the DoD wholesale ammunition stockpile. Members of the Army, Navy, Air Force and Marine Corps, as well as members of the SMCA, were surveyed twice. The first survey contained four statements, each referring to a different area of responsibility for the SMCA. These four areas of responsibility were SMCA storage of ammunition, SMCA demilitarization of ammunition, SMCA tiering program for depots, and SMCA customer support. The respondents were asked to provide positive and negative aspects for each area, as well as recommendations for improvements. The second survey sought to revalidate and summarize the expert opinions provided in the first survey regarding problem areas or areas for improvement. By evaluating how the respondents responded to each statement or question on the second survey, conclusions were drawn as to what the experts believed were the positive and negative aspects of the SMCA, as well as areas the experts believe could be improved. The study concluded that SMCA does well storing ammunition and managing demilitarization, that the tiering plan, conceptually, is a good idea and that SMCA customer satisfaction is an area that requires additional attention.

**14. SUBJECT TERMS**

Ammunition, Ammunition Management, Single Manager for Conventional Ammunition, Delphi Technique

**15. NUMBER OF PAGES**

78

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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Monte Carlo Analysis of Computerized Tomography

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Karyl J. Davis, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/ENP/GAP/95D-3

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt William Ruck
Radiation Safety Officer, WPMC
Wright-Patterson AFB OH 45433

I would like to offer my sincere thanks to Capt Karyl Davis, Capt Jeff Martin, Dr George John and Dr. Kirk Mathews for their efforts and interest in the project. The goal was to assess the adequacy of shielding in our computer tomography suite under the 100 mrem per year dose limit for members of the public. The approach taken, Monte Carlo analysis was far more sophisticated than standard techniques employed by clinical health physicists. The findings from the thesis project complement an ongoing effort to evaluate the shielding in our diagnostic suites.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**13. ABSTRACT** *(Maximum 200 words)*

This thesis modeled computerized tomography (CT) using Monte Carlo methods to determine the non-occupational dose outside the suite at Wright-Patterson Medical Center and at a generic suite. This was driven by the recent inclusion of the most recent NCRP recommended dose limits into 10CFR20. Modeling was done with MCNP, a general-purpose Monte Carlo N-particle transport model. WPMC average usage was used to establish usage factors and workload. Suite walls well lead shielding between gypsum drywall. Film badges placed in the CT suite were compared to MCNP modeling results to validate method and results. They agreed within a factor of two. Outside both the WPMC CT suite and the generic room, the continuous exposure non-occupational dose limit was exceeded below the floor and above the ceiling, the infrequent exposure non-occupational dose limit was exceeded below the floor. The occupational and non-occupational dose limit outside the x walls of the generic room was exceeded. The scattered radiation spectrum is softened source spectrum.

**14. SUBJECT TERMS**

Monte Carlo, computerized Tomography, Radiation Protection, Scattered, Radiation

**15. NUMBER OF PAGES**

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**4. TITLE AND SUBTITLE**

COST MANAGEMENT COMPETENCIES: THE IMPORTANCE AND FREQUENCY AS SEEN BY THE FINANCIAL ANALYST

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Diana E. Pry, Captain USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology,
WPAFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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WPAFB OH 45433

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

Excellent product we really needed. Capt Pry did top quality job. We very much appreciate her efforts.

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This research studied the application of cost management competencies in the financial management career field. The purpose was to determine how frequently these competencies are used by the financial analysts and how important they are in the analysts' work environment. To accomplish this research a mail survey was sent to 978 financial analysts across Air Force Materiel Command. Out of the 978 survey instruments sent, 535 were returned with useful data, for a response rate of 54.7%. From these surveys, 24 of the 49 competencies were identified as being valuable to financial analysts. The 24 competencies provide a framework for future education of the financial analysts. Additionally, 19 of the 24 competencies require education to the comprehension level of learning. Only five of the 24 most valuable competencies required achievement of an application level of learning. This result may provide insight for course directors faced with the challenge of appropriately structuring cost analysis courses.

**14. SUBJECT TERMS**

Cost, Cost Management, Competencies
Kruskal-Wallis, Financial Analysts, Surveys

**15. NUMBER OF PAGES**
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|---|---|---|---|

**4. TITLE AND SUBTITLE**

Personnel Airdrop Risk Assessment Using Bootstrap Sampling

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Won Sik Kim, Maj, ROKA

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/96D-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Mark A. Kuntavanish
C-17 APO
Wright-Patterson AFB OH 45433-6583

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT
BY
ABOVE SPONSOR =

Concepts developed by Maj Kim, LtC Bailey & LtC Lawson saved C-17 SPO 4 years and $2-$3 Million. Student and faculty were very accommodating and provided outstanding support. C-17 program would be at a loss without them.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

Previous work on personnel airdrop problems involving jumpers has been event-oriented entanglement rates, number of canopy "bumps", landing injuries, and deaths represent the typical metrics. The thesis expands this area of research by developing cumulative distribution functions of maximum possible chute entanglement risk for the C-17 using bootstrap techniques. By comparing the effects of various C-17 aircraft configurations on the entanglement CFD, this thesis shows that under certain configurations the risk of centerline entanglements for the C-17 is less than for the C-141.

**14. SUBJECT TERMS**

Experimental Design, Bootstrap Sampling, Modeling

**15. NUMBER OF PAGES**

84

**16. PRICE CODE**

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|---|---|---|---|

**4. TITLE AND SUBTITLE**

Analysis of Air Force Environmental Justice Methodology

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Barbara E. Owens, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Tom Adamcyk
AFCEE/ECP
Brooks AFB TX 78235-5000

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

Capt Owens did an outstanding job. Her thesis will serve as an excellent reference for thos studying the history and evoluation of the EJ process

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this study is to analyze AFCEE's draft environmental justice methodology. The study provides background on the meaning of environmental justice along with related terminology, and covers historical events of the environmental justice movement leading up to the publication of EO 12898 A discussion of EO 12898, subsequent draft guidance, and other pertinent literature leads to the development of evaluation criteria used to analyze both AFCEE's methodology and an application of that methodology: the March AFB Disposal Final Environmental Impact Statement. Given that AFCEE formed their own methodology to address environmental justice prior to any definitive guidance regarding the interpretation of EO 12898, the metrology and its application do extremely well at meeting the intent of EO 12898, per the evaluation criteria developed in the study. The framework for the evaluation criteria consists of four categories: demographic analysis, impact analysis, integration of demographic analysis and impact analysis, and community involvement. There re a total of 17 criteria within this framework. With respect to reflecting the requirements of EO 12898, AFCEE's draft methodology met ten criteria, was limited in five criteria, and did not meet two of the criteria. When a sample AFCEE application was analyzed, eight of the criteria were met, and nine were not met. This was due, in part, to the fact that the application was a Base Realignment and Closure Environmental Impact Statement.

**14. SUBJECT TERMS**

**15. NUMBER OF PAGES**
165

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| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Optimization of a GPS-Based Navigation Reference System

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Jason B. McKay, 2d Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/96D-12

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Jeff Hebert
746th TS/TGGED
Holloman AFB NM 88330-7850

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

Would not have been able to do as thorough an analysis without AFIT. Helps make multi-million dollar procurement decisions.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The development of increasingly accurate new aircraft navigation systems has caused the Air Force to develop a new Navigation Reference System to test them, called the Submeter Accuracy Reference System (SARS). The SARS is an inverted GPS system which consists of an array of GPS receivers on the ground and an airborne pseudolite mounted on the test aircraft. The SARS will provide a proof position estimate that is used to check the navigation system under test. Unfortunately, ground based inverted GPS systems tend to suffer from high geometric sensitivity to measurement errors. This research tackles the problem of optimizing the SARS receiver array configuration to minimize the system's sensitivity to pseudorange errors. The analysis determines that the proper choice of cost function for the optimization is the condition number of the $H$ matrix, rather than the commonly used GDOP. Insight into the problem is provided by a graphical technique for evaluating receiver array geometry. Moreover, two receiver array numbered optimization programs are developed. The results of the receiver array optimization show that the geometric sensitivity to error in the SARS airspace can be reduced to acceptable levels through proper array design. Several good receiver array designs are shown. Finally, a technique for further reducing the geometric sensitivity of the SARS is discussed.

**14. SUBJECT TERMS**

Navigation Reference Systems, SARS, Global Positioning System, GPS, Pseudolite, Geometric Dilution of Precision, GDOP

**15. NUMBER OF PAGES**

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| | March 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Modeling Space in the Air Force Command Exercise System (ACES)

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert Payne, Jr., Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOA/ENS/96M-04

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Robert F. Donohue, Jr.
CADRE/WGTA
Maxwell AFB AL 36112-6428

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR

Well thought out; used student expertise and available SLAM modeling to make points; conclusions changed my opinion of including space play into our current game, but will be at a more generic level.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

In response to the increased influence of space forces on today's battlefield, several theater level models were analyzed for the presentation of space forces. These models were the Extended Air Defense Simulation (EADSIM), the Joint Theater Level Simulation (JTLS), the Integrated Theater Engagement Model (ITEM), the Tactical Warfare Model (TACWAR), Thunder, Janus, and the Aggregate Level Simulation Protocol (ALSP). While ALSP is not a model but a simulation protocol connecting various models, it was studied because it appears to be the future of modeling. The consensus of the analysis was that space forces are virtually ignored by most of the models. The Air Force Command Exercise System (ACES) was chosen to determine how the effects of space forces can be implemented into theater level models. ACES is a discrete event combat simulation designed to support intermediate and senior service schools teaching Air Force doctrine within the context of a theater warfare exercise. Its primary focus is to allow specific educational goals to be taught. This research focused on both the present modeling of space forces within widely used theater level models and a methodology to incorporate space forces into models that lack the influence of space.

**14. SUBJECT TERMS**

Combat Model; Space

**15. NUMBER OF PAGES**

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**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE March 1997 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

A Decision Support System for Joint Force Air Component Commander (JFACC) Combat Planning

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Donald W. Hinton, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GAO/ENS/97M-09

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Levesque
HQ ACC/XP-SAS
Langley AFB VA 23665-2778

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**During Blue Flag, Col Pratt, 9AF/Combat Operations, served as the senior member of combat plans in Guidance, Apportionment and Targeting (GAT). The GAT cell uses the JFACC guidance to build the ATO overnight. that briefs results to the JFACC in the morning. Here are come of his comments: Impressive. Very Valuable aid. Allows good summary of package information and package flow. Great summary analysis. Now have ability to accurately recapture ATO specifics.**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This system allows assessment of the Master Air Attack Plan (MAAP) during construction and at completion. The system functions around a relational database management system providing a decision support tool for the Guidance, Apportionment, & Targeting (GAT) cell of Central Command's JFACC Combat Plans. A Microsoft Access application is programmed to provide PC-based, real-time evaluation of air campaign goals and constraints. The decision support system was validated in February 1997 by the CENTAF combat plans staff at Blue Flag 97-1. The software and user's manual are maintained at HQ ACC/XP, Studies and Analysis Squadron.

**14. SUBJECT TERMS**

Decision Support System, Joint Force Air Component Commander (JFACC), Master Air Attack Plan, Air Campaign Planning

**15. NUMBER OF PAGES** 68

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| | March 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A Methodology for the Analysis and Prediction of Air Force Officer Retention Rates

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Mark A. Basalla, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENC/96M-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj Tony Garton
HQ AFPC/DPSAA
Randolph AFB TX 78150-4738

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

ASSESSMENT BY ABOVE SPONSOR =

Our office did not have the time or money to investigate this topic. We are grateful that AFIT could help us with our workload. Almost every quarter DoD, Congress, CSAF on down asks our office to predict AF retention rates. Capt Basalla has helped up grapple with the question, versus telling this senior leadership that we are unable to answer the question.

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

The purpose of this study is to investigate the effects of certain national economic conditions and certain Air Force related conditions on officer retention rates and to build, verify, and validate a multivariate linear regression model to be used by Air Force personnel management officials that will predict officer retention rates for rated and non-rated line officers aggregated by Yeargroups and AFSC groups. Previous retention models were reviewed to study possible predictors and methodologies. The logit transformation was used on the logistic regression model for simplification. D. R. Cox gives three assumptions, that were valid in this case, so ordinary least squares was used to estimate the parameters of the logit model. The tournament approach of the Modified Miller's Method was used for variable selection. This new approach was first validated by computer simulation and then used in the model building process for all of the models in this effort. The output of this tournament approach was the model of choice for each AFSC and Yeargroup. Two-way without replication ANOVA was done in order to combine like AFSCs into several groups. There were six groups in all. A separate model was then build for each of the six groups.

**14. SUBJECT TERMS**

Officer Retention, Logistic Regression, Logit, Modified Miller's Method, Tournament Approach

**15. NUMBER OF PAGES**

73

**16. PRICE CODE**

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| | March 1997 | Final |

**4. TITLE AND SUBTITLE**

Variation of the Air Force Global Weather Center Relocatable Window Model Total Cloud Forecast

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Edward C. Harris, 2d Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GM/ENP/97M-07

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Lou Cantrell
HQ AFGWC/SYSM
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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

SYSM has been seeking methods to forecast mission cloud impact variables. We've reviewed diagnosis method such as SLINGO tested by Lt Harris... and we are now investigating stochastic techniques .... using Penn State's MM5 mesoscale forecast model. Lt Harris' results have contributed to our decision to replace RWM with MM5. The cost savings to AFGWC by not implementing SLINGO into the RWM is approximately $120K...Lt Harris has ensured that our modeling efforts do not stray off the path of highest productivity.

**11. SUPPLEMENTARY NOTES**  ASSESSMENT BY ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

Air Force Global Weather Center's (AFGWC) Relocatable Window Model (RWM) total cloud forecasts were validated using data for selected days in May, June, and July 1996. Forecasts were generated twice daily (00 UTC and 12 UTC) to determine the RWM's ability to accurately forecast total cloud cover during the late spring and early summer. The RWM forecasts were post-processed using the Slingo cloud forecast algorithm and compared against AFGWC's operational real-time nephanalysis (RTNEPH) cloud analysis model. As a minimal-skill baseline comparison to the RWM's total cloud forecast, RTNEPH initial analysis hour was persisted and evaluated against the same RTNEPH analysis as the RWM forecasts. The results of the study suggest RWM total cloud forecasts did not show improved skill, sharpness, accuracy or bias when compared against RTNEPH persistence through the 36-hour forecast period. The results also suggest the Slingo algorithm, as tested, is not appropriate for use in the RWM as an accurate total cloud forecast method for the late spring and early summer months over the North American Window.

**14. SUBJECT TERMS**

Air Force Global Weather Center (AFGWC), Relocatable Window Model (RWM), Slingo, Real-Time Nephanalysis (RTNEPH)

**15. NUMBER OF PAGES**

165

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**4. TITLE AND SUBTITLE**

Transportation Modeling of Remote Radar Sites and Support Depots

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Sonia E. Leach, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/97M-13

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Ogdensburg NY 13669-0430

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

A complete and thorough product that we can build on.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** (Maximum 200 words)

The North Warning System (NWS), a joint program of the US Air Force (USAF) and the Royal Canadian Air Force (RCAF), is responsible for the maintenance of 47 remote radar sites across northern Canada. NWS's current airlift operations, which support the radar maintenance activities, consist of both helicopters and fixed wing aircraft positioned at five support depots. This thesis considers whether a reconfiguration of these support depots and the assignment of radar sites to them can result in either an airlift or total cost savings for NWS. Mixed integer linear programming models were formulated to address the questions surrounding a configuration of the NWS which might gain airlift cost savings. Several operational scenarios were considered. The analysis identifies that cost savings may be realized through a number of possible actions.

**14. SUBJECT TERMS**

Linear Programming, Integer Programming, Mixed Integer Linear Programming, Facility Location, Transportation

**15. NUMBER OF PAGES**

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**4. TITLE AND SUBTITLE**

Moisture Sensitivity of Contrail Forecast Algorithms

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Allen C. Rabayda, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GM/ENP/97M-08

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

first of all contrails are still a concern and there's much we don't know about contrail formation which limits our ability to forecase them. An important question in contrail formation is just how important upper-level moisture is. This has been a question we've been trying to answer for several years in an effort to imporove out contrail forecasting capability. Capt Rabayda's thesis.
 helped answer that question.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis looked at using new relative humidity (RH) climatologies to improve the Air Force Global Weather Center's (AFGWC) contrail forecasts. To study the effect of the new RH climatologies, the currently used empirical relative humidity (RH) profile is replaced with a more accurate climatological one, Stratospheric and Gaseous Experiment II (SAGE II). To compare the forecasted base accuracy and bias, the study examines sets of forecast bases generated by both the empirical and SAGE II profiles on 42 days. Each set of forecast bases are shown to be statistically similar with a series of hypothesis tests. Additional RH profiles with values from 0% to 100% are then tested to gate their affect on forecast bases. Again little statistical difference in forecast bases are noted between the additional profiles. In general, a high forecast base bias is shown for two algorithm derived from the Appleman theory. This thesis a;so reveals the dependence of forecast bases on RH and lapse rate  Lapse rates from $2^\circ$C/km to $9^\circ$C/km and forecast bases generated by RH values of 0% and 100% are used to show how RH variations of more than 30% may only vary forecasts by less than 1,000 feet.

**14. SUBJECT TERMS**

**15. NUMBER OF PAGES**
159

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**4. TITLE AND SUBTITLE**

Implementing Information Warfare in the Weapon Targeting Process

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

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**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION
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**10. SPONSORING/MONITORING
AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT
BY
ABOVE SPONSOR =

**Would not have been smart enough to start on our own. We are working to add real (classified) data to apply the concept developed in this thesis into trade-off analysis and targeting tools.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

A key challenge to integrating new information warfare (IW) weapons into the existing weapon targeting process is than many IW weapons have soft -kill characteristics that do not offer easy comparison to traditional hard-kill weapons. A variety of weapons from each of the six pillars of IW will be considered to include operations security, military deception, psychological operations, electronic warfare, physical destruction, and information attack weapons. These multi-criteria measures are used to develop a basis for a methodology for allocating a mix of IW and conventional weapons to a set of targets to accomplish a specific operational goal.

**14. SUBJECT TERMS**

Information Warfare, Weapon Targeting, Operational Effectiveness, Combat Effectiveness, Kill Probabilities, Mathematical Models, Goal Programming

**15. NUMBER OF PAGES**
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**16. PRICE CODE**

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| | March 1997 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Ranking and Generating Alternatives for the National Air Intelligence Center's (NAIC) Resource Allocation Strategy

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Steven M. Cox, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

The work was very useful. It needed to be done, but contract dollars or in-house manpower were not available to do it. Both Lt Col Kloeber and Capt Cox's efforts were of benefit.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT** *(Maximum 200 words)*

Allocating resources is never an easy task, especially when requirements call for more resources than those available. It gets more difficult when the availability of resources shrinks from year to year. This is the case at the National Air Intelligence Center (NAIC). In each of the past five years, NAIC has been forced to make their resource allocation decision with fewer dollars and less manpower. This decision has been time consuming, manpower intensive, and sometimes very heated. In an effort to lessen these three consequences, a resource allocation model, based upon the NAIC Commander's values and preferences, was developed. The methodology for the model is founded upon decision analysis with value-focused thinking. Using multi-attribute utility theory, measures were scored using scoring functions and then multiplied by the commander's preferences to determine an overall utility score. For the FY99 budget cycle at NAIC, 62 unique funding proposals were scored and ranked using 28 measures fro each proposal. The developed value hierarchy allows NAIC to choose their own alternatives based on this ranked list. Significant differences in perceived impact exist between recommended proposal cuts and the list of proposals approved for cuts by NAIC. Some sensitivity analysis was performed on the commander's preferences.

| 14. SUBJECT TERMS | | | 15. NUMBER OF PAGES |
|---|---|---|---|
| NAIC, MAUT, Value-Focused Thinking, Resource Allocation, Desicion Analysis, Reduction | | | 132 |
| | | | 16. PRICE CODE |

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| | February 1997 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Sensitivity of Availability Estimates to Input Data Characterization

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Darren P. Durkee, Maj, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/97-06

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Kirtland AFB NM 87117

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = **Excellent support from graduate student and each member (Dr. Mykytka, Major Murdock, Major Pohl) of committee.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

Reliability analysts are often faced with the challenge of characterizing the behavior of system components based on limited data. Any insight into which model input data is most significant and how much data is necessary to achieve desired accuracy requirements will improve the efficiency and cost effectiveness of the data collection and data characterization processes. This thesis assesses potential significant factors in the probabilistic characterization of component failure and repair behavior with respect to the effect on system availability estimates. Potential factors were screened for significance utilizing factorial and Plackett-Burman experimental designs for several system models developed using an AFOTEC simulation program entitled RAPTOR. Two input data characterization factors were found to have significant affect on availability estimation accuracy: the size of the structure and the number of data points used for component failure and repair distributional fitting. Estimation error was minimized when the structures analyzed were small and many data points (in this case, 25) were used for the distributional fittings. Assuming constant component failure rates and using empirical repair distributions were found to be equally effective component characterization methods (pertaining to model availability estimation error) compared to using automated software fitting tools (or 'wizards'). The results of this study also indicate that there is no apparent benefit in concentrating on important components for the highest fidelity distributional fittings.

**14. SUBJECT TERMS**

Availability Estimation, Fractional Fractional Experiment, Component Reliability, Distributional Assumptions

**15. NUMBER OF PAGES**

134

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**4. TITLE AND SUBTITLE**

Modeling and Analyzing the Effect of Ground Refueling Capacity on Airfield Throughput

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

W. Heath Rushing, 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/97M-19

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Maj Laura R. C. Suzuki
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Scott AFB IL 62225-5307

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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Some of the analysis of real data was particularly useful since I would not have had the time to do the analysis. I will use this information.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis develops five analytical models to understand the current ground refueling process, to optimize the airfield configuration and to determine the refueling policy which maximizes throughput, the primary measure of airfield efficiency. This study models the airfield refueling process as a continuous time Markov process to adequately represent the inherent stochastic nature of the transitory ground refueling system and provide an analytical evaluation of various airfield configurations. Also, the study provides an optimal refueling policy to minimize the number of aircraft on the ground which in turn minimizes the average amount of time aircraft spend on the ground in a fifth model, a Markov decision process solved by a linear program. By accomplishing this, higher throughput rates can be achieved by allowing a higher aircraft arrival rate into the airfield.

**14. SUBJECT TERMS**

Markovian Modeling, Continuous Time Markov Process, Markov Decision Process, Throughput, Airfield Refueling, Ground Refueling, FORTRAN, CPLEX, IMSL, Stochastic Modeling

**15. NUMBER OF PAGES**

108

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|---|---|---|---|

**4. TITLE AND SUBTITLE**

An Examination of the Hanson Contrail Forecast Algorithm Under Low Relative Humidity Conditions

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Robert P. Asbury III, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GM/ENP/97M-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Steve Weaver
88th Weather Squadron
Wright-Patterson AFB OH 45433-2704

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

One concern that we have is which forecast algorithm works best. Capt Ashbury's thesis helped answer that question. His research clearly showed that the Hanson algorithm is flawed and cannot accurately forecast contrails when the upper atmosphere is dry (which it normally is). We would not have completed this work if AFIT had not done it. This simply because we don't have the money to contract out such work. (The Geophysics Directorate of Phillips Lab said they could do it for $100K or so).

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Accurate forecasts of contrail occurrence are essential to military aircrews. Although classical forecast methods have been reasonably successful predicting contrails, there is need for improvement at low ambient relative humidity This thesis examines the performance of the Hanson method, which was developed to provide better contrail forecasts under drier atmospheric conditions. As a secondary objective, the forecast methods of Schumann and Hanson are compared to the algorithm currently in use by the Air Force Global Weather Central. Data used to validate the algorithms were collected at Wright-Patterson AFB OH and Edwards AFB CA. Theoretical contrail forecasts were made for each observation, using the flight level pressure, ambient temperature, and relative humidity Comparisons were then made between the forecast and actual observation of contrail conditions. Forecast and occurrence data were then statistically analyzed to gauge each method's performance. All methods detected roughly 75 percent of observed contrails under moist atmospheric conditions. However, the Hanson method's performance decreased when drier atmospheric observations were tested. Schumann's method performed as well as the AFGWC algorithm under all atmospheric conditions. Based on this research, the Hanson method is not recommended for operational use.

| 14. SUBJECT TERMS<br>Contrails, Pressure, Relative Humidity, High Bypass Engine | | | 15. NUMBER OF PAGES<br>115 |
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| | Mar 97 | Master's Thesis |

**4. TITLE AND SUBTITLE**
RESPONSE SURFACE METHODOLOGY: AN ANALYTICAL METHOD FOR LOCATING MIGRATED CONTAMINANT SOURCES

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
ORLANDO J. DONA, JR., 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Air Force Institute of Technology
2750 P Street
WPAFB, OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCS/ENC/97M-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND AD**
Mr. Rober Elliott, Chief, Environmental RestorationDiv
7274 WardleighRoad
Hill AFB, UT 84056-5137

This work is significant in finding better approaches to located waste. Because this is not front line RI/FS type work it is hard to dedicate resources to it.

**11. SUPPLEMENTARY NOTES**

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

**13. ABSTRACT** *(Maximum 200 words)*

The use and storage of hazardous chemicals at U.S. military facilities often adversely affect the groundwater when contaminants infiltrate the subsurface as a result of leaks and accidental spills. These contaminants, if not located and remediated in a relatively short time, may move and settle unpredictably, essentially creating a source some distance from the original leak or spill. An example of this phenomenon is found with migrating dense nonaqueous phase liquid (DNAPL) contaminants. Although various methods for estimating the present-day locations of these migrated contaminants are in use, accurately pinpointing the source of contaminants remains a difficult problem in current remediation technology. Response Surface Methodology (RSM) is a computer-enhanced statistical technique for empirical model building and exploitation that supports a systematic approach to site characterization. The use of RSM techniques may result in better mathematical models of a site and may ultimately enhance a site's conceptual model. This work demonstrates the use of RSM to pinpoint the statistically best locations of contaminant point sources that have migrated from their original location in several experiments, and outlines a process that has great potential for significantly reducing costs associated with site characterization and remediation.

**14. SUBJECT TERMS**
CONTAMIN GROUNDWATER SOURCE REMEDIATION CHARACTER MIGRAT

**15. NUMBER OF PAGES**
127

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| | March 1991 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Armored Vehicle Weapon Impact Assessment in Southeast Asia

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Stephen K. Walker, Capt, US Army

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/91M-20

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. Eugene Visco
Under Secretary of the Army

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

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Walker's work has been discussed at the 59<sup>th</sup> Military Operations Research Society Symposium, US Military Academy, June 1991. Will be a topic at XXX Army Operations Research Symposium, Ft Lee VA, November 1991, and 8<sup>th</sup> International Symposium on Military Operations Research, Royal Military College of Science, England, September 1991. As well as play a role in continuing research and analysis on casualty estimation and prediction in the US Army.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution Limited to DoD and DoD Contractors On

**13. ABSTRACT (Maximum 200 words)**

The goal of this study was to determine the relationship between battlefield physical insults, levels of protection, and the number and severity of casualties sustained by armored vehicle crews as a result of battlefield physical insults on armored vehicles in the Vietnam conflict. In addition, this study sought to establish the relationship between battlefield physical insults, levels of protection, and vehicle mission vulnerability. An automated database was constructed from paper records in the GRNVEHSEADB database maintained by SURVIAC. This data was analyzed using log-liner modeling, logit modeling, and contingency graphics. The results show that the severity of crew casualties and the impact of those casualties on vehicle mission vulnerability are functions of the vehicle model, threat weapon, and location of weapon impact. Although small sub-sample sizes render the predictive probabilities questionable, the dependence of the relationship is established. Additionally, it was shown that crew casualties were a significant factor in determining vehicle mission vulnerability when hit by a rocket propelled grenade. It was also shown that M113 APC driver casualties to land mines were twenty percent fewer when bolt-on armor was installed.

**14. SUBJECT TERMS**

Casualty, Vulnerability, Survivability, Southeast Asia, Vietnam, Armored Vehicle, Tanks (Combat Vehicle), Armored Personnel Carriers, Mine, Rocket Propelled Grenade

**15. NUMBER OF PAGES**

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|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br><br>The Potential for Minefield Detection from Space | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br><br>Joseph W. Snodgrass, Capt, US Army | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION**<br>**REPORT NUMBER**<br><br>AFIT/GSO/ENG/91D-01 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br>Robert L. Bernard<br>Belvoir Research, Development &<br>Engineering Center<br>Fort Belvoir VA 22060 | | | **10. SPONSORING/MONITORING**<br>**AGENCY REPORT NUMBER** |

Capt Snodgrass's paper is especially timely as interest in standoff mine detection has been piqued by the Gulf war experience and the maturing of the Standoff Minefield Detection System (STAMIDS) program which is expected to enter proof of principle phase this year. The consideration of further extending sensor standoff is appropriate given the increasing competitiveness of space platforms. The paper will assist the countermine community in focusing on the key elements
required to make such technical opportunities for user consideration.

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| **11. SUPPLEMENTARY NOTES** ASSESSMENT<br>BY<br>ABOVE SPONSOR = | |
| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Distribution limited to US Government<br>agencies | **12b. DISTRIBUTION CODE** |

**13. ABSTRACT** *(Maximum 200 words)*

Considerable progress has been made in recent years in the area of standoff minefield detection (SMD). But, techniques currently being developed operate from low altitude airborne platforms making them vulnerable and making the commander's interest in an area obvious to the enemy. SMD from space would address both of these limitations. This research takes a multi-disciplined approach to assessing the potential for SMD from space, considering remote sensing fundamentals, recent SMD experimental results, and space-based issues. The fundamentals of remote sensing limit and enable target detection in terms of resolution, ground penetration, and others. Synthetic aperture radar (SAR) technology at longer microwave wavelengths is theoretically the most promising sensor type. Experimentally, infrared detection technology has shown particular success at low altitudes, with an IR SMD system currently being developed for remotely-piloted vehicle mounting. Once orbital parameters such as the sensor-to-target range, overflight speed, and frequency of coverage are considered, it concluded that a space-based minefield detection system (SBMDS) relying on just one sensor would not be sufficiently capable. A multi-band SAR system would be more promising for SMD from space. Although currently unsuccessful at detecting buried mines, SAR offers high resolution, some ground penetration, and all-weather capability largely independent at range. Augmentation by a multi-spectral visible IR system may prove necessary.

| **14. SUBJECT TERMS**<br><br>Mine detection, Minefields, Patter Recognition, Remote Detectors, Synthetic Aperture Radar, Target Detection | | | **15. NUMBER OF PAGES**<br>121 |
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| 4. TITLE AND SUBTITLE Autonomous Face Segmentation | 5. FUNDING NUMBERS |
|---|---|
| **6. AUTHOR(S)** Kevin P. Gay | |

| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Institute of Technology Wright-Patterson AFB OH 45433-7765 | 8. PERFORMING ORGANIZATION REPORT NUMBER AFIT/GE/ENG/92S-06 |
|---|---|

| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Maj Rodney Winter DIR/NSA, R221 9800 Savage Road Ft Meade MD 20755-6000 | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER |
|---|---|

The results of this research are directly applicable to in-house efforts at NSA. The research is important enough that we would have had to do it ourselves, when we found the time to do it. The thesis states these results will be used in an overall system for face recognition. We look forward to reviewing these further developments. Thanks

**11. SUPPLEMENTARY NOTES**

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| 12a. DISTRIBUTION AVAILABILITY STATEMENT Distribution unlimited | 12b. |
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**13. ABSTRACT** (Maximum 200 words)

The purpose of this study was to implement an autonomous face segmentor as the front end to a face recognition system on a Sun SPARCStation2. Face recognition performance criteria, specifically, the capabilities to isolate and resize faces in an image to a consistent scale, were analyzed to determine current practical limitations. Face images were acquired using a S-VHS camcorder. Segmentation was accomplished using motion detection and pre-defined rules. Tests were run to determine the suitable of the autonomous segmentor as the front-end to a face recognition system. The segmentation system developed consistently located faces and rescaled those faces to a normalized scale for subsequent recognition.

| 14. SUBJECT TERMS Face Segmentation, Face Recognition, Segmentation | | | 15. NUMBER OF PAGES 125 |
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| | September 1993 | Master's Thesis |

**4. TITLE AND SUBTITLE**

An Analysis of Estimate at Completion Models Utilizing the Defense Acquisition Executive Summary Database

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Mark F. Terry
Mary M. Vanderburgh, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCA/LAS/93S-9

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Washington DC 20301-3000

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT
BY
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This research would be difficult if not impossible to duplicate elsewhere. Research design extremely well integrated and timely and relevant to current acquisition reform efforts.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 words)**

This study explores the widely held assertion that DoD contract Cost at Completion is bounded below by the Cost Performance Index-based Estimate at Completion (EAC) and above by the Schedule Cost Index-based EAC. Descriptive statistics determined the floor and ceiling for 321 DoD contracts. The results confirmed that the Cost Performance Index-based EAC is a reasonable floor and the Schedule Cost Index-based EAC is a reasonable ceiling for EAC formulas. For the contracts considered overall, on average, the Cost at Completion on average. Results were tested for sensitivity to Index Type (cumulative, six-month and three-month), Program Phase, Contract Type, Branch of Service, System Type, Branch of Service, System Type, Major Contract Baseline Changes and Management Reserve. Graphs of the EAC ceilings and floors for several contract categories illustrate trends in program status throughout various states of contract completion. These graphs should assist program analysts in providing program manages with reasonable contract completion cost estimates for contracts in various categories across all stages of contract completion.

**14. SUBJECT TERMS**

Estimate-at-Completion, Cost/Schedule Control Systems Criteria, Forecasting, Estimating

**15. NUMBER OF PAGES**

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| | December 1994 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Unification of Larch and Z-Based Object Models to Support Algebraically-Based Design Refinement: The Larch Perspective

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Catherine J. Lin, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

We are pleased with the initial results of this work and look forward to the ability to view specifications both in the object oriented paradigm and in the more formal specifications of Larch and Z. Further work shouldbe directed at interfacing the SPECWARE tool as soon as appropriate. The value of the work will increase when integrated with our emerging tools. Of secondary importance would be the ability to do static and dynamic analyses of the specifications. In the long term however, the types of additional analyses provided will be more beneficial then simply integrating with SPECWARE.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This research describes the feasibility of developing object-oriented Larch specifications, part of a dual approach for formally extending object-oriented analysis models using Larch and Z. The first phase consisted of two steps: establishing a set of transformation heuristics for algebraically representing object models and implementing a robust Larch parser. The Larch parser produced abstract syntax trees (ASTs) of objects forming the basis for analyzing similarities and differences between Z-based and Larch-based object representations. The second phase used the analysis of Larch and Z to identify fundamental core constructs in the languages and abstract syntax trees. These core constructs consisted of similar syntactic and semantic notions of signatures and axioms for describing a problem domain, thereby forming a canonical framework for formal object representations. This canonical framework provides a front-end for producing design refinement artifacts such as interface languages, theorem proving sentences, and synthesis diagrams. The final phase demonstrated the feasibility of interface language gauge generation by establishing an executable framework. The executable framework mapped Larch into the Software Refinery™ Programming Environment to rapidly prototype object-oriented Larch specifications.

**14. SUBJECT TERMS**

Computers, Computer Programs, Software Engineering, Specifications, Formal Specification Languages, Application Composition Systems, Larch

**15. NUMBER OF PAGES**

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**4. TITLE AND SUBTITLE**

COST/SCHEDULE CONTROL SYSTEMS CRITERIA INTERPRETATION
DIFFERENCES BETWEEN THE DOD AND ITS CONTRACTORS

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Brian E. Hoffmann II, Captain USAF
Johnny Wilson, Captain USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology,
WPAFB OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GSM/LAS/94-S-6

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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Room 3E1025: The Pentagon
Washington DC 20360-5000

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**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**Work being led by Dr. Christensen
continues to build on excellent foundation
established by his previous students.**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** (Maximum 200 words)

This study attempted to identify the major interpretive differences of the Cost/Schedule Control Systems Criteria (C/SCSC) between Department of Defense (DoD) and contractor performance management professionals, and to understand why these differences occurred. As the study progressed, its focus shifted to an evaluation of the *Interpretive Guide*, an Air Force Institute of Technology (AFIT) published document used to assist in the understanding of the criteria elements. The objective of the evaluation was to determine if the *Interpretive Guide*'s explanations of the criteria elements were in consonance with the intent of the criteria and with current practice in the field of performance management. Research packages were distributed to and collected from performance management professionals in the DoD and its contractors. No distinct interpretative differences of the criteria were found between the two groups but a number of suggestions to improve the content of the *Interpretive Guide* were suggested; some of the recurring suggestions were to address the concept of integrated product teams and the development of procedures to streamline the area of variance analysis reporting. Respondents comments were published in an appendix and summarized within the text. Recommendations were to update the *Interpretive Guide* as well as to perform further research.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES |
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| Cost/Schedule Control Systems Criteria, C/SCSC, Education, Performance Management, Performance Measurement, AFIT, DOD, Contractors, Industry, Interpretive Guide, NSIA | 237 |
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| **4. TITLE AND SUBTITLE**<br><br>Assessing the Vulnerability of Multi-Commodity Networks with Failing Components | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br>Alan R. Robinson, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GOR/ENS/94M-12 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>Lt Col Larry Pulcher<br>R&D Bldg R5<br>9800 Savage Road<br>Ft Meade MD 20775 | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

When Alan completed this research he probably knew more about this topic than anyone at the NSA. He did some important work for us in developing a new approach to representing a difficult problem. Because we were able to have Alan assigned to NSA, we will be able to take advantage of his knowledge to continue the work.

| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | **12b.** |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

This research proposes an analytical approach for assessing flow disturbance, or "compromise," based on limited sampling of arc flow information in multi-commodity, or multiple origin-destination (O-D), networks with failing arcs. There were three objectives established for this research. The first objective was to bound the expected flow, given the arcs fail with certain probabilities, which was accomplished by reviewing current approaches for single-commodity networks and extending the results to the multi-commodity case. The second objective was to determine the best placement of flow monitors to obtain the most accurate estimates of O-D pair volumes. This was accomplished using a multi-criteria approach for defining all possible monitor placement strategies satisfying monitor availability. The O-D pair volumes were estimated using the $l$-norm metric for varied levels of $p$. The final objective was to define a compromise metric providing confident assessments on the occurrence of "compromise." This was accomplished using simple regression techniques to generate confidence intervals around the expected flow for each O-D pair. The approach proposed in this research is provided as an initial look into "compromise" assessment based on limited network information.

| **14. SUBJECT TERMS**<br>Networks, Reliability, Vulnerability, Origin-Destination Matrix, Multi-Commodity Networks | | | **15. NUMBER OF PAGES**<br>168 |
|---|---|---|---|
| | | | **16. PRICE CODE** |
| **17. SECURITY CLASSIFICATION OF REPORT**<br>Unclassified | **18. SECURITY CLASSIFICATION OF THIS PAGE**<br>Unclassified | **19. SECURITY CLASSIFICATION OF ABSTRACT**<br>Unclassified | **20. LIMITATION OF ABSTRACT**<br>UL |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>March 1994 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|
| **4. TITLE AND SUBTITLE**<br><br>An Air Mission Planning Algorithm for a Theater Level Combat Model | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br>Brian J. Griggs, Maj, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GST/ENS/94m-5 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br><br>Lt Col Mark Youngren<br>The Joint Staff, J-8/CFAD<br>Room 1D940, The Pentagon<br>Washington DC 20301-8000 | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |

**11. SUPPLEMENTARY NOTES**   ASSESSMENT BY ABOVE SPONSOR =

Major Griggs and the faculty of the ENS Department were very helpful in formulating a problem and solution that have direct application to model research underway at the Joint Staff (J-8). The key to this product was the combination of operational expertise in air mission planning with the technical expertise provided by the operations research curriculum. We look forward to future collaboration on similar projects.

| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | **12b. DISTRIBUTION CODE** |
|---|---|

**13. ABSTRACT** *(Maximum 200 words)*

This thesis describes the development of an air mission planning algorithm for the Joint Staff's Future Theater Level Model (FTLM). The overall problem scope was to develop an algorithm to handle major factors bearing on the combat mission planning problem while providing hook-ups for the FTLM architecture. Other aspects of the problem included finding the appropriate level of detail, developing a fast solving technique, and attempting to use existing data. The problem was handled by using some ideas from existing aircraft allocation algorithms and by adding some new techniques. The proposed air mission planning algorithm supplies the optimum degree of force for campaign objectives by using a linear program (LP) to allocate the optimum number and type of aircraft and munitions against each target. The LP takes advantage of the force multiplying effects of mass and mutual support through its use of strike packages with SEAD and air-to-air escort. Additionally, a decision tree algorithm determines the best plan in light of the uncertainties of weather and weather forecasts. This air mission planning algorithm omits many of the details in the actual aircraft tasking process, but provides fast, nearly optimal solutions which should approximate real world tasking results.

| **14. SUBJECT TERMS**<br><br>Aerial Warfare, Air Force Operations, Linear Programming, Mathematical Models | | | **15. NUMBER OF PAGES**<br>72 |
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| | | | **16. PRICE CODE** |
| **17. SECURITY CLASSIFICATION OF REPORT**<br><br>Unclassified | **18. SECURITY CLASSIFICATION OF THIS PAGE**<br><br>Unclassified | **19. SECURITY CLASSIFICATION OF ABSTRACT**<br><br>Unclassified | **20. LIMITATION OF ABSTRACT**<br><br>UL |

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| | September 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

An Analysis of the Purpose and Development of Management Reserve

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Kevin T. Gould, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

OUSD(A) APR/PM
Washington DC 20330

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
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Significant in that it helps advance understanding of earned value as project management tool related to technical schedule and risk management ( as opposed to financial reporting system).

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This study investigates both the purpose and development of management reserve budget as it pertains to the Cost/Scheduled Control Systems Criteria outlined in DoD Instruction 5000.2. With the Defense Department facing an environment of shrinking budgets, it is becoming increasingly critical for them to manage their acquisition programs as efficient and effective as possible. The objectives of this study were to gain insight, from both a government and commercial perspective, on both the purpose and the development of the contractor's management reserve budget. Contractor system descriptions and interviews of individuals associated with the government acquisition process were used to document and analyze the objectives of the study. The contractor system descriptions and personal interviews both provided detailed information on the purpose of the contractor's management reserve budget. However, neither data source provided a consistent, objective methodology for developing an accurate and comprehensive contractor's management reserve budget.

**14. SUBJECT TERMS**

Management Reserve Budget, Cost/Schedule Control Systems Criteria, Contractor System Description, Management Control Systems, Participative Budgeting

**15. NUMBER OF PAGES**

59

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| | September 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**
THE PROCESS OF PROVIDING HUMANITARIAN ASSISTANCE:
A DEPARTMENT OF DEFENSE PERSPECTIVE

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Rhonda M. Smith, Captain, USAF
Barbara J. Stansfield, Major, USA

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GIM/LAL/95S-5

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

USOTSG/Log Consultant
Falls Church, VA 22041

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**   ASSESSMENT BY ABOVE SPONSOR = Of great value to JWFC joint electronic library as part of peace operations database.

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

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**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This research effort was a qualitative study on the current process of how the DOD provides humanitarian assistance. Currently the process is not well defined and is situation dependent. Historical documents and current guidelines, policies, and regulations were researched for information on what types of humanitarian assistance the DOD provides, how the process is initiated, and who is involved in the process. Agencies outside of the military, both civilian and government were researched to determine the extent of coordination necessary for the military to provide humanitarian assistance. A model was compiled to portray the current process and given to key personnel identified in the research as subject matter experts. Subsequently, their opinion was used to determine the validity of the model and gather additional points of contact for future research. Once the process and key players were defined, additional research can be started to further determine the effectiveness of using the DOD to provide humanitarian aid.

**14. SUBJECT TERMS**
Humanitarian Assistance, Low Intensity Conflict, Military Operations Other Than War, Peacekeeping, Humanitarian Aid, Humanitarian Missions, Disaster Relief.

**15. NUMBER OF PAGES**
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| | September 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

A COMPARATIVE STUDY OF LINEAR AND NONLINEAR ESTIMATE AT COMPLETION METHODS

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Todd D. Nystrom, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

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**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
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Research builds on earlier work done by AFIT and is significant because it reaffirms earlier work and suggests productive avenues for future work.

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

Controlling costs in the acquisition of new defense systems is a major challenge in today's environment of declining budgets and rapidly changing technology. One of the challenges faced by program managers and cost analysts is selecting the most appropriate Estimate at Completion (EAC) method for their program. This study compares the performance of the popular index-based EAC methods with several newer nonlinear regression-based EAC methods to determine whether the complex nonlinear methods perform better than the simpler index-based methods. In addition, the sensitivity of the results to stage of contract completion, system type, program phase, contract type, Department of Defense service component, and inflation effects are also investigated.

Eighty-eight contracts were examined in this study and it was found that overall the index-based EAC methods performed significantly better than the nonlinear regression-based methods as measured by two criteria, the accuracy and stability of the EACs. In addition, the tip performing method overall was determined to be the index-based method using the Composite Index ($0.2SPI_{cum}+0.8CPI_{cum}$). The best performing method was, however, sensitive to all of the factors investigated in the sensitivity analysis.

**14. SUBJECT TERMS**

Estimate at Completion, Cost/Schedule Control Systems Criteria, Cost Estimating, Rayleigh Distribution, Beta Distribution, Multiple Model Adaptive Estimation

**15. NUMBER OF PAGES**

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| | March 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Performance Study of Shared Versus Nonshared Bandwidth on a Packet-Switched

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

John P. Stevens, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Lt Col Elbert B. Head
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9800 Savage Road
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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = **Having the student work a problem for the gaining organization is very beneficial for both parties.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

In wide-area computer data communications, many networks have evolved by satisfying increased user demands in the most expedient manner. In some cases, new users' demands are satisfied by installing a new link, rather than sharing the links that are already in place. This research investigates the differences in performance between using a dedicated link for each source-destination pair (nonshared bandwidth) and using a single link to be used by all source destination pairs (shared bandwidth). Simulation models are developed for a wide-area network using shared bandwidth, and a wide-area network using nonshared bandwidth. The quality of service offered by each network is based on its responsiveness and productivity. Responsiveness will be measured in terms of average end-to-end delay of packet transmission, and productivity will be measure in terms of percent bandwidth utilization. The networks are modeled under a common set of operating assumptions and system environment. This allows for accurate comparison of packet delay and bandwidth utilization. Two variable input parameters are used in the simulation: intensity of input traffic load, and amount of link capacity. Provided that the intensity of the input traffic load remains below the network saturation level, it is shown that the shared system clearly outperforms the nonshared system. This result occurs for both a uniform and nonuniform traffic load destination distribution.

**14. SUBJECT TERMS**

Shared Bandwidth, Network Performance, Packet-Switching Wide-area Communication Network

**15. NUMBER OF PAGES**

136

**16. PRICE CODE**

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|---|---|---|---|

**4. TITLE AND SUBTITLE**

Text-Independent, Open-Set Speaker Recognition

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Stephen V. Pellissier, Capt, US Army

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

This work helped a lot in the ultimate success of our project -- would like to broaden this cooperation in the future

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**13. ABSTRACT** *(Maximum 200 words)*

Closed-set speaker recognition systems abound, and the overwhelming majority of research in speaker recognition in the past has been limited to this task. A realistically viable system must be capable of dealing with the open-set task. This effort attacks the open-set task, identifying the best features to use, and proposes the use of a fuzzy classifier followed by hypothesis testing as a model for text-independent, open-set speaker recognition. Using the TIMIT corpus and Rome Laboratory's GREENFLAG tactical communications corpus, this thesis demonstrates that the proposed system succeeded in open-set speaker recognition. Considering the fact that extremely short utterances were used to train the system (compared to other closed-set speaker identification work), this system attained reasonable open-set classification error rates as low as 23% for TIMIT and 26% for GREENFLAG. Feature analysis identified the liftered linear prediction cepstral coefficients with or without the normalized log energy or pitch appended as a robust feature set (based on the 17 feature sets considered), well suited for clean speech and speech degraded by tactical communications channels. Finally, in contrast to previous efforts which have used codebooks consisting of 35-512 codewords, codebook analysis revealed that relatively small codebooks (with as few as 8-10 codewords) are adequate, if not optimal, in terms of classification accuracy and computational complexity for vector quantization-based classification techniques.

**14. SUBJECT TERMS**

Speaker Recognition, Speaker Identification, Open-Set, Closed-Set, Fuzzy Classification, Vector Quantization, Hypothesis Testing, Speech Features

**15. NUMBER OF PAGES**

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| | December 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Performance Analysis of Preemption Algorithms in an IDNX Circuit Switch Communications Network

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Eric C. Gumbs, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = **Capt Raines [faculty] did an outstanding job of supporting both Capt Gumbs and NSA.**

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** (Maximum 200 words)

Access to communication networks is increasing rapidly. The increased access to these networks results in delays and at times loss of data. At times of peak traffic or when trunks or nodes are down, very important customers' communications requirements are not met. One way to combat this problem is to prioritize the network and provide different levels of grade of service (GoS) for each priority. Call preemption provides an effective method of obtaining different levels of GoS. This research seeks to design the best circuit switch communications network preemption model for the DoD by analyzing previously developed preemption algorithms. Four simulation network models are developed. The grades of service per priority are obtained as the network capacity decreases and as the calls generated in node 0 increases. The analysis of preemption network models are simulated under the same input parameters. The analysis showed that preemption can significantly lower the grade of service for high priority customers in a congested network. The best configuration preemption models depends on the bandwidth flexibility of the network and the goals of the communications network organization.

**14. SUBJECT TERMS**

Call Preemption, Priority, Communication Networks, Bones Designer, IDNX, Grade of Service (GoS), Preemption Algorithms, Simulation, Topology

**15. NUMBER OF PAGES**

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**4. TITLE AND SUBTITLE**

Habitat Suitability Through Integration of Multicriteria Evaluation Techniques with a Geographic Information System (GIS)

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Anthony A. Ference, Capt, USMC

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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**8. PERFORMING ORGANIZATION REPORT NUMBER**

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**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Jeffery Caspers, USMC
AC/S Envirn
Camp Pendleton CA 92055

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR =

An excellent thesis which contributed greatly towards integrating numerous expert opinions in a focused direction. Approach was cutting-edge analysis, wound in thought and reasoning. Enthusiastically received by regulatory community.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

The presence of an endangered species, the Pacific Pocket Mouse (PPM), in critical Marine Corps training areas aboard Camp Pendleton may adversely affect training activities that are crucial to meeting the Marine Corps' mission. Camp Pendleton must focus limited budgetary assets for live trapping surveys of the PPM in the areas of best habitat suitability and the purpose of this study was to develop a PPM habitat suitability map of Camp Pendleton. Suitability maps were developed by integrating expert opinion with the Camp Pendleton Geographic information System (GIS) database. The seven points scale multicriteria evaluation methodology was implemented to solicit the importance of ground characteristics (criteria) for PPM habitat from field experts. The criteria of interest were coastal proximity, soil type, and vegetation class. The evaluations of the respondents were in agreement. Suitability scores and preference weights were determined from questionnaire responses and input into the ARC/INFO GIS program. Habitat suitabilities were calculated as weighted averages of suitability scores of individual ground characteristics. The criterion and combined suitability maps produced agreed well with known locations of the PPM. This indicated that the evaluations and methodology were valid. Coastal proximity was determined to be eliminated from future research in this area.

**14. SUBJECT TERMS**

Environment, Environmental, Endangered Species, Habitat Suitability, Mapping, Multicriteria evaluation, Geographic Information Systems (GIS), multicriteria Decision Making (MCDM)

**15. NUMBER OF PAGES**
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
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| **4. TITLE AND SUBTITLE**<br><br>Laser-Induced Breakdown Spectroscopy on Solution Samples Using Surface Excitation | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)**<br><br>Leonard M. Berman, Capt, USAF | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**<br><br>Air Force Institute of Technology<br>Wright-Patterson AFB OH 45433-7765 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER**<br><br>AFIT/GAP/ENP/96D-03 |
| **9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**<br>Dr. Ernesto R. Cespedes<br>US Army Corps of Engineers<br>Waterways Experiment Station (CEWES-B)<br>3909 Halls Ferry Road<br>Vicksburg MS 39180 | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |
| **11. SUPPLEMENTARY NOTES**<br>ASSESSMENT<br>BY<br>ABOVE SPONSOR = | I enjoyed the technical discussions with Professor Wolf regarding LIBS research and applications. | | |
| **12a. DISTRIBUTION AVAILABILITY STATEMENT**<br><br>Approved for public release; distribution unlimited | | | **12b. DISTRIBUTION CODE** |

**13. ABSTRACT** *(Maximum 200 words)*

Laser-induced breakdown spectroscopy (LIBS) is a spectroscopic technique where output from a pulsed laser is focused onto a target in order to create an intense plasma. The optical emission is characteristic of the elements in the focal volume and can be used for elemental analysis. Research on the detection of nickel in solution in addition to solvent detection of $CCl_4$, $CHCl_4$, $C_2CL_4$, and $C_2HCl_3$ has been performed. Breakdown was formed at the sample surface via a Q-switched Nd YAG laser. Initially, operation of the laser was at 1064 nm/repetition rate of 5Hz. Experiments were also performed using the third harmonic (355 nm)/repetition rate of 20 Hz. Pulse energy was maintained at 60 mJ. The spark light was spectrally resolved and detected by a time gated photodiode array. A $50\mu s$ gate width/$8\mu s$ time delay gave detection limits of 56.1 mg/1 for nickel in solution. In the UV, $\partial\ 10\mu s$ gate width/$3\mu s$ mg/1. Using UV excitation ($10\mu s$ gate width/$1\mu s$ time delay), saturated solvent solutions as high as 7.71 G/! were not detectable.

| **14. SUBJECT TERMS**<br><br>Emission Spectroscopy, Laser Spark, Spetrochemistry Laser Microspectral Analysis, Optical Breakdown | | | **15. NUMBER OF PAGES**<br>97 |
|---|---|---|---|
| | | | **16. PRICE CODE** |
| **17. SECURITY CLASSIFICATION OF REPORT**<br><br>Unclassified | **18. SECURITY CLASSIFICATION OF THIS PAGE**<br><br>Unclassified | **19. SECURITY CLASSIFICATION OF ABSTRACT**<br><br>Unclassified | **20. LIMITATION OF ABSTRACT**<br><br>UL |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE<br>December 1996 | 3. REPORT TYPE AND DATES COVERED<br>Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

Evaluation of Near Field Electromagnetic Scattering Codes for Use in Anti-Aircraft Missile Endgame Simulations

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

James M. Taylor, Jr., Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GE/ENG/96D-20

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Capt Samuel McKenzie
USSTRATCOM/J534
Offutt AFB NE 68113-6500

Capt Taylor's research in development of his thesis contributed directly to the success of on-going efforts by my staff to improve our endgame modeling against low observable vehicles. Our current end game simulation uses a simple stick-and-cone fuse model technique which is adequate for conventional platforms. However, low observable platforms need a more complex modeling technique to evaluate the threat system fusing capabilities against our low observable penetrating assets. Capt Taylor's thorough analysis of various near field radar cross section prediction codes helped us select the best code to meet our requirements and contract-needed modeling improvement. His efforts have helped immeasurably in improving our endgame simulation and ensuring USSTRATCOM's mission.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to DoD and DoD contractors; Contains propriety Information (2 Dec 96); Other Requests for this documents must be addressed to USSTRATCOM.

**13. ABSTRACT** *(Maximum 200 words)*

The information of low observable aircraft into the modern battlefield has changed the performance characteristics of many weapon systems, anti-aircraft missiles included. An area of interest to the Air Force now how low observable features applied to an aircraft will affect the ability of anti-aircraft missiles to fuze properly. Current estimates on fuze effectiveness are based on a simple stick-and-cone model where detection of the target is independent of the reflectivity of the target. While this model has been sufficient for conventional targets, a low observable target may have a different response. Present near-exact computational methods can model the electromagnetic scattering from complex objects, like aircraft, but they require too much computational effort for reasonable simulation run times. Approximate methods are available that can obtain faster scattering solutions from simple objects arranged to simulate the target; however, errors can be substantial depending on the complexity of the object being modeled. The purpose of this thesis is to examine near field electromagnetic scattering codes for use in missile endgame simulations. The results of this analysis can be used to select a scattering code that will improve the overall fidelity of missile endgame simulations used by the Air Force.

**14. SUBJECT TERMS**

Cross sections, Electromagnetic Scattering, Guided Missile Fuzes, Near Field, Proximity Fuzes, Radar Cross Sections, Simulation

**15. NUMBER OF PAGES**
158

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE December 1996 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |
|---|---|---|

**4. TITLE AND SUBTITLE**

A Specific Network Link and Path Likelihood Prediction Tools

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Gary K. Moy, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCS/ENG/96D-21

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Lt Col Elbert B. Head
Department of Defense (R55)
9800 Savage Road, Ste 6550
Ft Meade MD 20755-6000

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR = Capt Raines (faculty advisor) did an outstanding job as an interface between the student and our organizations

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

In this study, Dijkstra's algorithm has been modified to allow the Queueing Network Analyzer's (QNA) analysis output to act as a node's goodness metric. QNA's calculation of the expected Sojourn Time in a node provides accurate measurement of expected congestion. The modified Dijkstra's algorithm in the Generalized Network Analyzer (GNA) is verified and empirically validated to properly deliver traffic from start to destination. GNA's Congestion Control displays notification and informs the user certain network input parameters must be lowered or where certain nodes must be improved to maintain node stability. Upon successful completion of the analysis, GNA outputs the generated route and expected sojourn time for later analysis. Use of two analysis techniques show the percentage of link usage within a 25 node test network. Three analytical techniques are provided to estimate the probable bounds of the input parameters and sojourn times. Using these techniques, a bound of the Total Sojourn Times is provided for a 16 node test network. Given few input parameters, networks analyzed can provide a specific link usage probability and path likelihood. Since QNA requires a few calculations and GNA's Congestion Control provides unstable node identification, designers and engineers can evaluate network topologies much more easily.

**14. SUBJECT TERMS**

Generalized Network Analyzer, GNA, Queueing Network Analyzer, QNA, Whitt Communication Networks, Computer Networks, Topology, Queueing Theory

**15. NUMBER OF PAGES** 175

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UL |
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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE September 1992 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
|---|---|---|---|

**4. TITLE AND SUBTITLE**

An Analysis of Acquisition Logistics Within the National Aeronautics and Space Administration

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Brian J. Babin, Capt, USAF
Roger W. Jerney, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GLM/LSY/92S-2

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

NASA/JI
NASA Headquarters
Washington DC 20546

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT BY ABOVE SPONSOR =

Good approach - good paper! This paper will aid in NASA's continuing drive to improve "acquisition logistics" and thereby develop systems with better focus on the operations phase.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**12b.**

**13. ABSTRACT (Maximum 200 words)**

The purpose of this study was to review past actions and assess current plans for establishing more integrated logistics management in NASA. The focus of this study was acquisition logistics, the beginning of the ILS process. This study includes a historical review of acquisition logistics in NASA's major space programs as well as a review of numerous acquisition logistics models. Logistics managers from the Space Shuttle and Space Station Freedom programs were interviewed, surveyed, and observed to provide evidence of the degree to which these two programs are meeting or have met the objectives of the acquisition logistics model selected as most appropriate. Findings indicated that the Space Station Freedom, like the Space Shuttle program, is losing support and funding for ILS programs. NASA managers are opting to sacrifice long range cost savings in exchange for lower system development costs. Recommendations include increased emphasis on educating the management and engineering communities of NASA on the benefits of well supported and funded acquisition logistics programs.

**14. SUBJECT TERMS**

Acquisition, Logistics, NASA, Procurement, Model, Space Shuttle, Space Station

**15. NUMBER OF PAGES** 145

**16. PRICE CODE**

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| | December 1995 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Probabilistic Knowledge Base Validation

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Howard T. Gleason

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GCS/ENG/95D-04

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

June Zakrajek
NASA Lewis Research Center/SPTD
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Cleveland OH 44135
Mail Stop SPTD-2

Dr. Abraham Waksman
AFOSR/NM
Bolling AFB DC 20332

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES** ASSESSMENT BY ABOVE SPONSOR = This is a worth while step toward the meaningful marriage of logic base systems with NNs.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

Our work develops a new methodology and tool for the validation of probabilistic knowledge bases throughout their lifecycle. The methodology minimizes user interaction by automatically modifying incorrect knowledge; only the occurrence of incomplete knowledge involves interaction. These gains are realized by combining and modifying techniques borrowed from rule-based and artificial neural network validation strategies. The presented methodology is demonstrated through BVAL, which is designed for a new knowledge representation, the Bayesian Knowledge Base. This knowledge representation accommodates incomplete knowledge while remaining firmly grounded in probability theory.

**14. SUBJECT TERMS**

Bayesian Knowledge Bases, Bayesian Networks, Machine Learning, Neural Networks, Validation, Verification, Requirements, Probabilistic Reasoning, Expert Systems

**15. NUMBER OF PAGES**

88

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | March 1997 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Statistical Modeling and Optimization of Nuclear Waste Vitrification

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Todd E. Combs, 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOA/ENS/97M-02

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Department of Energy
555 Qunice St
Gaithersburg MD

Interested in improved model predictive capabilities.. We would have used existing models - not aware of neural network approach. I believe it does provide an improvement in the Department of Energy's ability to predict the acceptable composition ranges for high level radioactive glasses. This is particularly important because of the long term risk associated with these types of waste forms. The implications of an incorrect prediction could be signficant and costly.

**11. SUPPLEMENTARY NOTES** ASSESSMENT
BY
ABOVE SPONSOR

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

This thesis describes the development of a methodology to minimize the cost of vitrifying nuclear waste. Pacific Northwest Laboratory (PNL) regression models are used as baseline equations for modeling glass properties such as viscosity, electrical conductivity, and two types of durability. Revised PNL regression models are developed that eliminate insignificant variables from the original models. The Revised PNL regression model for electrical conductivity is shown to better predict electrical conductivity than the original PNL regression model. Neural networks are developed for viscosity and the two types of durability, PCT-B and MCC-1B. The neural network models are shown to outperform every PNL and Revised PNL regression model in terms of predicting property values for viscosity, PCT-B and MCC-1B. The combined Neural Network/ Revised PNL 2nd order electrical conductivity models are shown to be the best classifiers of nuclear waste glass, i.e., they have the highest probability of classifying a vitrified waste form as glass when it actually did produce glass in the laboratory. Finally, five nonlinear programs are developed with constraints containing 1) the PNL original 1st order models, 2) the PNL original 2nd order models, 3) the Revised PNL 1st order models, 4) the Revised PNL 2nd order models, and 5) the Neural Network/Revised conductivity nonlinear program is shown to minimize the total expected cost of vitrifying nuclear waste glass. This nonlinear program allows DOE to minimize its risk and cost of high-level nuclear waste vitrification.

| 14. SUBJECT TERMS | | | 15. NUMBER OF PAGES |
|---|---|---|---|
| Nuclear Waste Vitrification, Regression Models, Neural Networks, Mathematical Programming | | | 172 |
| | | | **16. PRICE CODE** |

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | June 1997 | Master's Thesis |

**4. TITLE AND SUBTITLE**

Analysis of Tethers in Sampling Near Earth Objects

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

John W. Wong, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GSO/ENY/97J-1

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. John J. Nieberding
NASA Lewis Research Center/SPTD
2100 Brookpark Road
Cleveland OH 44135
Mail Stop SPTD-2

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

Electric propulsion applications are of interest - no work currently in either. We are always looking for missions which are not possible with chemical propulsion but enabled by electric propulsion.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

A

**13. ABSTRACT** *(Maximum 200 words)*

This study investigated the feasibility of a SAIC proposal to sample New Earth Objects (NEOs) from an orbiting spacecraft using a tethered landing device. The parameters for suitable targets were derived from an analysis of a proposed point design as applied to current knowledge of NEOs. Tether strength and lifetime for the point design were also assessed. First order modeling of tether dynamics showed that deployment and attachment to a NEO are feasible. The dynamics of retrieving a sample via a crawler unit which crawls up the tether requires further exploration.

**14. SUBJECT TERMS**

Tethers, Near Earth Objects, Asteroids, Spacecraft, Sample Collection, Space

**15. NUMBER OF PAGES**

134

**16. PRICE CODE**

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**4. TITLE AND SUBTITLE**

Evaluation of an Engineering Design Process

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Zachary H. Foulk, Capt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GST/ENS/94M-03

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

Mr. William Todd
Inland Fisher Guide Division
General Motors Corporation
PO Box 5051
Vandalia OH 45377

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

As a result of this work, Inland Fisher Guide is sponsoring three more masters and a doctoral thesis in 1995. These projects will further define out processes. We will continue until all our processes are completely defined. The doctoral assignment will be to link all the process parts together so we can evaluate the impact of proposed process changes.

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Distribution limited to US Government agencies only; proprietary information. Other requests for this document must be referred to Inland Fisher Guide Division, Vandalia OH 45377

**13. ABSTRACT (Maximum 200 words)**

This study used network modeling to evaluate an engineering design process. The design process contained quality control activities which incorporated feedback network branching. The network was analyzed with a stochastic simulation program instead of PERT. Analysis techniques used included pseudo-random number testing for uniformity and independence, and analysis of variance to determine significant activities. A resolution IV experimental design was used to evaluate the improvement of the average project completion for different quality control activity settings. All significant activities identified were quality control activities that contained feedback network branching, and improvements in the project completion time were estimated based on reductions in the probability of feedback branching. A simplified strategic network model was constructed to demonstrate the integration of the detailed tactical model into a decision support system.

**14. SUBJECT TERMS**

Critical Path Methods, Mathematical Models, Network Analysis (Management), Random Number Testing, PERT, Simulation

**15. NUMBER OF PAGES**

209

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| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | September 1996 | Master's Thesis |

**4. TITLE AND SUBTITLE**
*PRIVATIZATION IN PLACE AND THE BASE CLOSURE COMMUNITY: NEWARK AIR FORCE BASE, OHIO, 1993-1995*

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
Paul D. Pidgeon, Captain, USAF

**7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)**

Air Force Institute of Technology
2750 P Street
WPAFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GTM/LAL/96S-12

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

The Licking County Port Authority
Attn: Mr. Wallace Horton
PO Box 2330
Heath OH 43056

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

ASSESSMENT
BY
ABOVE SPONSOR →

I worked with Capt Pidgeon providing him access to our Reuse Port Authority files. He did excellent job, provided good insight. Capt Pidgeon should be commended.

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT (Maximum 200 Words)**

This thesis studies the experience of the local community during the privatization in place of Newark Air Force Base (NAFB), Ohio. Licking County faced the loss of its largest employer after the 1993 Base Realignment and Closure Commission (BRACC), a five-year commission established by President George Bush as a measure to cut national defense spending after the Cold War's end, recommended closing the Air Force repair facility. Licking County leaders sought help from elected officials to have the Air Force implement a plan that would keep the NAFB workload in place under the auspices of private industry--privatization in place.

At stake for Licking County were jobs for over 1,500 base employees and a $200 million economic impact. Licking County leaders cited a new federal initiative announced by President Clinton--the Five Part Program for Revitalizing Base Closure Communities--as justification for privatization in place. Licking County leaders also sought help from the man who founded the base over thirty years earlier to lead a push for privatization in place. An in-depth historical analysis identifies the critical issues as seen through the eyes of the local community and places them in an economic and political context.

**14. SUBJECT TERMS**
Depot, Privatization, Base Closure, Base Realignment and Closure Commission (BRACC), Privatization in Place, Base Reuse, Politics

**15. NUMBER OF PAGES**
153

**16. PRICE CODE**

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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE February 1997 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |
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**4. TITLE AND SUBTITLE**

A Cost Impact Assessment Tool for PFS Logistics Consulting

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Angela P. Giddings, 1st Lt, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Air Force Institute of Technology
Wright-Patterson AFB OH 45433-7765

**8. PERFORMING ORGANIZATION REPORT NUMBER**

AFIT/GOR/ENS/97M-08

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

William K. Clarkson
PFS Logistics Consulting
14841 Dallas Parkway
Dallas TX 75240

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

Angela did very detailed, professional work She broke new ground, both theoretically as well as real world applicability. I think the project was mutually beneficial. We received a process tool to enhance our analysis capability allowing us to focus our resources on areas with greatest return. In return the Air Force was exposed to PepsiCo and our logistics practice. The tool that Angela developed works with INSIGHT SAIL ( Strategic Analysis for Integrated Logistics Systems). The tool and the process we use to analyze logistics networks may be useful in Angela's career. We truly enjoyed working with Angela and Glenn Bailey. Both are extremely bright and professional.

**11. SUPPLEMENTARY NOTES**

ASSESSMENT
BY
ABOVE SPONSOR =

**12a. DISTRIBUTION AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. ABSTRACT** *(Maximum 200 words)*

Response surface methodology (RSM) is used for optimality analysis of the cost parameters in mixed integer linear programming. The mixed integer linear programming problems of interest are the large-scale problems in supply chain optimization--also knows as facility location and allocation problems. Furthermore, this optimality analysis technique applies to optimality analysis of costs or right-hand-side elements in continuous linear programs and optimality analysis of costs in mixed or pure integer linear programs. A system which automates this process for supply chain optimization at PFS Logistics Consulting is also presented, along with description of its application and impact in their daily operations.

**14. SUBJECT TERMS**

Optimality Analysis, Response Surface Methodology, Design of Experiments, Group Screening, Mixed Integer Linear Programming, Supply Chain Optimization, Metamodels

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**12a. DISTRIBUTION AVAILABILITY STATEMENT**

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**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 words)**

This thesis presents a preliminary design of an ionospheric sounder to be carried aboard one or more of NASA's Mars Surveyor landers. Past Russian and American probes have indicated the existence of an ionosphere, but none of these missions remotely sensed this atmospheric layer from the surface. The rationale for utilizing a surface-based Martian ionospheric sounder is discussed. Based on NASA's choice of launch vehicle and power source, a low-weight, low-powered Chirpsounder using a horizontally-polarized dipole antenna is recommended for the sounder experiment. The sounder experiment should be conducted for at least one Martian year, in order to investigate significant changes in radio propagation during seasonal transitions. Specific data compression techniques are suggested in order to reduce the quantity of data transferred from each sounder. The Appendix presents an overview of Earth's ionospheric structure and solar cycle effects. Finally, a Matlab software model of a hypothetical ionogram as measured from the Martian surface is presented.

**14. SUBJECT TERMS**

Ionosphere, Sounding, Mars, Planetary Atmospheres

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